**Technical Support Document (TSD)**
**for the Final Rule**
Docket ID No. EPA-HQ-OAR-2021-0668

# Final Non-EGU Sectors TSD

U.S. Environmental Protection Agency
Office of Air and Radiation
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# 1 Introduction/Purpose

The purpose of this Technical Support Document (TSD) is to discuss the basis for the final emissions limits and monitoring, recordkeeping, and reporting requirements for the following emissions unit types in non-EGU industries: engines in the Pipeline Transportation of Natural Gas industry; kilns in the Cement and Cement Product Manufacturing industry; boilers and reheat furnaces in the Iron and Steel Mills and Ferroalloy Manufacturing industry; furnaces in the Glass and Glass Product Manufacturing industry; high-emitting equipment and large boilers in the Basic Chemical Manufacturing, Petroleum and Coal Products Manufacturing, Metal Ore Mining, and Pulp, Paper, and Paperboard Mills industries, and incinerators in the Municipal Waste Combustor industry. This TSD provides additional information to supplement the discussion in the preamble to the final rule on the basis for EPA's final emissions limits for each non-EGU unit and industry. All non-EGU emission limits identified in the final rule are set at a level that can be met through the installation of the control strategies identified in the preamble and further discussed in this TSD.

# 2 Pipeline Transportation of Natural Gas

Based on available information in the National Emissions Inventory (NEI), EPA has determined that reciprocating engines are the largest collective sources of nitrogen oxides (NOx) emissions from the Natural Gas Transportation Industry in the states covered by this final FIP. As explained in the Non-EGU Screening Assessment memorandum, the largest potential $NO_X$ emission reductions are from natural gas-fired spark ignition engines. Based on the NEI data, EPA has not identified a potential for significant emission reductions from turbines and compression ignition engines in this industry in the states covered by the final FIP. The process descriptions, background on each engine type, and summaries of applicable "reasonably available control technology" (RACT) emission limits and permit conditions, as well as a discussion of available $NO_X$ controls, are summarized in an analysis developed by the Ozone Transport Commission entitled *Technical Information Oil and Gas Sector Significant Stationary Sources of $NO_X$ Emissions* (October 17, 2012) ("OTC Engine Study"). The three types of engines for which EPA is finalizing emission limits in this final FIP are: 1) two stroke lean burn spark ignition engines, which are covered on pages 17-28 of the OTC Engine Study; four stroke lean burn spark ignition engines, which are covered on pages 30-42 of the OTC Engine Study; and four stroke rich burn spark ignition engines, which are covered on pages 44-52 of the OTC Engine Study.

EPA is finalizing an applicability threshold for spark ignition engines of 1000 horsepower (hp) or more. Based on the Non-EGU Screening Assessment memorandum, engines with a potential to emit of 100 tpy or greater had the most significant potential for $NO_X$ emissions reductions. EPA reviewed available information in the NEI and determined that many engines above 1000 hp reported emissions above 100 tpy, while engines smaller than 1000 hp generally reported emissions below 100 tpy.[1] Specifically, EPA only noted two engines below 1000 hp that emitted more than 100 tpy, while over 200 engines over 1000 hp emitted greater than 100 tpy. In addition to the NEI data, EPA observed that uncontrolled emissions from engines can be as high as 16.8 grams per horsepower per hour (g/hp-hr).[2] In addition, operating hours can be as high as 7000 hours in a given year.[3] With these assumptions, EPA could justify regulating engines around 800 hp or more. While the available data indicate that average operating hours are below 7000 hours per year,[4] in light of the potential variability in operating hours and the clear potential for these sources to emit in excess of 100 tons per year, EPA is

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[1] *See* 2017 NEI Engines Emissions.xlsx, available in the docket for this rulemaking.

[2] *U.S. Environmental Protection Agency*, Stationary Reciprocating Internal Combustion Engines: Technical Support Document for NOx SIP Call (October 2003); *U.S. Environmental Protection Agency*, Assessment of Non-EGU NOx Emission Controls, Cost of Controls, and Time for Compliance Final TSD, 5-8 (August 2016); *Illinois Environmental Protection Agency*, Technical Support Document for Controlling Emissions from Stationary Reciprocating Internal Combustion Engines and Turbines, 41 (March 19, 2007).

[3] *Illinois Environmental Protection Agency*, Technical Support Document for Controlling Emissions from Stationary Reciprocating Internal Combustion Engines and Turbines, 41 (March 19, 2007).

[4] OTC Engine Study, 88 (October 17, 2012) (explaining that the average operating hours was around 35% or around 3066 hours a year); *Illinois Environmental Protection Agency*, Technical Support Document for Controlling Emissions from Stationary Reciprocating Internal Combustion Engines and Turbines, 41 (March 19, 2007) (assuming operating hours for engines at 7000 hours a year); *U.S. Environmental Protection Agency*, Assessment of Non-EGU NOx Emission Controls, Cost of Controls, and Time for Compliance Final TSD, 5-6 through 5-9 (August 2016) (assuming operating hours of 2000 hours a year).

finalizing an applicability threshold of 1000 hp that is appropriately tailored to the scope of the screening assessment and should capture the majority of potential emission reductions.

**Federal Rules Affecting Engines**

Natural gas-fired spark ignition engines are subject to the New Source Performance Standards (NSPS) for Stationary Spark Ignition Internal Combustion Engines (40 CFR part 60, subpart JJJJ) and National Emission Standards for Hazardous Air Pollutants (NESHAP) for Stationary Reciprocating Internal Combustion Engines (40 CFR part 63, subpart ZZZZ).

**Four Stroke Lean Burn Spark Ignition Engines**

For four stroke lean burn spark ignition engines, EPA is finalizing an emissions limit of 1.5 g/hp-hr. EPA believes that installation of a selective catalytic reduction (SCR) system or a combination of other control technologies should be available for these engines to meet this emission limit. As explained in the OTC Engine Study, most of the four stroke lean burn spark ignition engines should be able to achieve 60 to 90% emission reductions with the installation of layered combustion controls, such as the installation of turbochargers and inter-cooling, pre-chamber ignition or high energy ignition, improved fuel injection control, air/fuel ratio control, etc.[5] With reduction in this range, these engines should be able to achieve an emissions limit of 1.5 g/hp-hr or less. For some engines that can only achieve a 60% reduction from layered combustion controls, information suggests that those engines should be able to install SCR to lower emissions to 1.5 g/hp-hr.[6] Further information about control measures to reduce NOx emissions from four stroke lean burn engines is shown below in the table excerpted from EPA's Menu of Control Measures for NAAQS Implementation.[7]

Many states containing ozone nonattainment areas or located within the Ozone Transport Region (OTR) have already adopted emission limits similar to or even significantly more stringent than the final emissions limit of 1.5 g/hp-hr. While some states have required limits equivalent to or even lower than 0.5 g/hp-hr,[8] most states have adopted emission limits at or close to 1.5 g/hp-hr.[9] Additional examples of state RACT rules and permitted emission limits can be found in the "$NO_X$ Permit Limits and RACT Tool spreadsheet" available in the docket. Many of these example RACT rules contain emission limits based on engine manufacture dates and set higher emissions limits between 1.5 and 3.0 g/hp-hr for older engines.

In addition to RACT limits, some four stroke lean burn spark ignition engines may have installed equipment to meet the emission limits contained within EPA's NSPS located at 40 CFR 60, subpart JJJJ, which requires that these engines meet a NOx emissions limit of 1.0 g/hp-hr if manufactured on or after July 1, 2010 and a NOx emissions limit of 2.0 g/hp-hr if manufactured

[5] OTC Engine Study, 43.
[6] Id.
[7] EPA, Menu of Control Measures for NAAQS Implementation, available at https://www.epa.gov/air-quality-implementation-plans/menu-control-measures-naaqs-implementation (URL dated January 5, 2022).
[8] See, e.g., South Coast Air Quality Management District Rule 1110.2, establishing a $NO_X$ emissions limit of 36 ppmvd, which is equivalent to about 0.5 g/hp-hr.
[9] For example, see Colorado Air Quality Control Commission Regulation 7, Part E, Section I, Table 1 and Table 2 (establishing emissions limits at 0.7 to 2.0 g/hp-hr depending on engine construction dates).

on or after July 1, 2007 but before July 1, 2010.[10] Given that many of the newer engines subject to this FIP are already required to meet the more stringent NSPS limits of 1.0 to 2.0 g/hp-hr, EPA's final FIP is targeting an emission limit that older engines not subject to the NSPS could still meet.

Based on the example RACT rules, applicability of the NSPS to newer engines, and the feasibility of $NO_X$ reductions analyzed in the OTC Engine Study, EPA believes an emissions limit of 1.5 g/hp-hr is achievable by the vast majority of four stroke lean burn spark ignition engines and will achieve the necessary $NO_X$ reductions for engines that are not subject to equivalent RACT requirements or the NSPS at 40 CFR 60, subpart JJJJ.

**Four Stroke Rich Burn Spark Ignition Engines**

For four stroke rich burn spark ignition engines, EPA is finalizing an emissions limit of 1.0 g/hp-hr. EPA believes that installation of non-selective catalytic reduction (NSCR) or a combination of other control technologies should be available for these engines to meet this emission limit. As explained in the OTC Engine Study, most of the four stroke rich burn spark ignition engines should be able to achieve 90 to 99% emission reductions with the installation of NSCR.[11] A 90 to 99% emission reduction should result in an emissions level of 1.0 g/hp-hr or less. Further information about control measures to reduce NOx emissions from four stroke rich burn engines is shown below in the table excerpted from EPA's Menu of Control Measures for NAAQS Implementation.

Many states containing ozone nonattainment areas or located within the Ozone Transport Region (OTR) have already adopted emission limits similar to the final emissions limit of 1.0 g/hp-hr. While some states have required limits equivalent to or even lower than 0.2 g/hp-hr,[12] most states have adopted emission limits at or close to 1.0 g/hp-hr.[13] Additional examples of state RACT rules and permitted emission limits can be found in the "$NO_X$ Permit Limits and RACT Tool spreadsheet" available in the docket. Many of these example RACT rules contain emission limits based on engine manufacture dates and set higher emissions limits at or close to 1.0 g/hp-hr for older engines.

In addition to RACT limits, some four stroke rich burn spark ignition engines may have installed equipment to meet the emission limits contained within EPA's NSPS located at 40 CFR 60, subpart JJJJ, which requires that these engines meet a NOx emissions limit of 1.0 g/hp-hr if manufactured on or after July 1, 2010 and a NOx emissions limit of 2.0 g/hp-hr if manufactured on or after July 1, 2007 but before July 1, 2010. *See* 40 CFR part 60, subpart JJJJ, Table 1. Further, some of these same units will have already installed NSCR to comply with EPA's NESHAP for Stationary Reciprocating Internal Combustion Engines at 40 CFR Part 63 subpart ZZZZ. Even though the NESHAP at subpart ZZZZ does not regulate $NO_X$ emissions, the

[10] *See* 40 CFR part 60, Subpart JJJJ, Table 1.
[11] OTC Engine Study at 45-46.
[12] *See* Pennsylvania General Permit 5 for Natural Gas Production and Processing Facilities, establishing $NO_X$ emissions limits for four stroke rich burn engines as low as 0.2 g/hp-hr.
[13] For example, see Colorado Air Quality Control Commission Regulation 7, Part E, Section I, Table 1 and Table 2 (establishing emissions limits at 0.5 to 2.0 g/hp-hr depending on engine construction dates).

installation of NSCR on these units should already provide the co-benefit of reducing $NO_X$ emissions to the levels necessary to comply with the final FIP.

Based on the example RACT rules, applicability of the NSPS to newer engines, and the feasibility of $NO_X$ reductions analyzed in the OTC Engine Study, EPA believes an emissions limit of 1.0 g/hp-hr is achievable by the vast majority of four stroke lean burn spark ignition engines and will achieve the necessary reductions.

**Two Stroke Lean Burn Spark Ignition Engines**

For two stroke lean burn spark ignition engines, EPA is finalizing an emissions limit of 3.0 g/hp-hr. EPA believes that installation of layered combustion controls or a combination of other control technologies should be available for these engines to meet this emission limit. As explained in the OTC Engine Study, most of the two stroke lean burn spark ignition engines should be able to achieve 60 to 90% emission reductions with the installation of layered combustion controls, such as the installation of turbochargers and inter-cooling, pre-chamber ignition or high energy ignition, improved fuel injection control, and air/fuel ratio control. [14] Available information suggests that some engines that can only achieve a 60% reduction from layered combustion controls will only be able to meet an emission limit of 3.0 g/hp-hr or greater. While some of these engines could install SCR to achieve greater reductions, EPA does not have information indicating that manufacturers and models of two stroke learn burn spark ignition engines generally can install the necessary combination of layered combustion controls and SCR to achieve a more stringent limit.[15] Further information about control measures to reduce NOx emissions from four stroke lean burn engines is shown below in the table excerpted from EPA's Menu of Control Measures for NAAQS Implementation.

Many states containing ozone nonattainment areas or located within the OTR have already adopted emission limits similar to the final emissions limit of 3.0 g/hp-hr. While some states have adopted limits equivalent to or even lower than 0.5 g/hp-hr,[16] most states have adopted emission limits between 1.0 g/hp-hr and 3.0 g/hp-hr.[17] Additional examples of state RACT rules and permitted emission limits can be found in the "$NO_X$ Permit Limits and RACT Tool spreadsheet" available in the docket. Many of these example RACT rules contain emission limits based on engine manufacture dates and set higher emissions limits closer to 3.0 g/hp-hr for older engines.

In addition to RACT limits, some two stroke lean burn spark ignition engines may have installed equipment to comply with EPA's NSPS at 40 CFR part 60, subpart JJJJ, which requires that these engines meet a NOx emissions limit of 1.0 g/hp-hr if manufactured on or after July 1, 2010 and a NOx emissions limit of 2.0 g/hp-hr if manufactured on or after July 1, 2007 but before July 1, 2010. *See* 40 CFR part 60, subpart JJJJ, Table 1. Given that many of the newer

[14] OTC Engine Study at 45-46.
[15] OTC Engine Study at 45-46.
[16] See South Coast Air Quality Management District Rule 1110.2, establishing a $NO_X$ emissions limit of 36 ppmvd or about 0.5 g/hp-hr.
[17] For example, see Colorado Air Quality Control Commission Regulation 7, Part E, Section I, Table 1 and Table 2 (establishing emissions limits at 1.0 to 3.0 g/hp-hr depending on engine construction dates).

engines subject to this final FIP are already required to meet the more stringent NSPS limits of 1.0 to 2.0 g/hp-hr, EPA's final FIP is targeting an emission limit that older engines not subject to the NSPS could still meet.

Based on the example RACT rules, applicability of the NSPS to newer engines, and the feasibility of $NO_X$ reductions analyzed in the OTC Engine Study, EPA believes an emissions limit of 3.0 g/hp-hr is achievable by the vast majority of four stroke lean burn spark ignition engines and will achieve the necessary reductions for engines that are not subject to equivalent RACT requirements or the NSPS at 40 CFR part 60, subpart JJJJ.

**Additional Information on NOx Controls**

EPA's Menu of Control Measures (MCM) provides state, local and tribal air agencies with information on existing criteria pollutant emission reduction measures as well as relevant information concerning the efficiency and cost effectiveness of the measures.[18] State, local, and tribal agencies may use this information in developing emission reduction strategies, plans and programs to assure they attain and maintain the NAAQS. The information from the MCM can also be found in the Control Measures Database (CMDB), a major input to the Control Strategy Tool (CoST), which EPA used in the NOx control strategy analysis included in the Non-EGU Screening Assessment memorandum.[19] Information about control measures to reduce NOx emissions from stationary internal combustion engines in service of the pipeline transportation of natural gas is tabulated below.

[18] EPA, Menu of Control Measures for NAAQS Implementation, available at https://www.epa.gov/air-quality-implementation-plans/menu-control-measures-naaqs-implementation (URL dated January 5, 2022).
[19] EPA, Control Measures Database (CMDB) for Stationary Sources, available at https://www.epa.gov/system/files/other-files/2021-09/cmdb_2021-09-02_0.zip (URL dated Janu ary 13, 2023).

**Table 2.A: $NO_X$ Controls Available for Natural Gas Fired Spark Ignition Engines**

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| Lean Burn ICE - NG | Air to Fuel Ratio Controller | 20 | This control is the use of air/fuel ratio adjustment to reduce NOx emissions. This control applies to gasoline powered internal combustion engines with uncontrolled NOx emissions greater than 10 tons per year. | CARB 2001, EPA 2018, RTI 2014 |
| Internal Combustion Engines - Gas | Adjust Air to Fuel Ratio | 20 | This control is the use of air/fuel ratio adjustment to reduce NOx emissions. This control applies to natural gas-fired internal combustion engines with uncontrolled NOx emissions greater than 10 tons per year.<br>Capital and annual cost information was obtained from model engine data in the Alternative Control Techniques (ACT) Document -- NOx Emissions from Stationary Reciprocating Internal Combustion Engines (EPA 1993c). | EPA 1993c, Pechan 1998a, Pechan 2006 |
| Internal Combustion Engines - Gas | Adjust Air to Fuel Ratio and Ignition Retard | 30 | This control is the use of air/fuel and ignition retard to reduce NOx emissions. This control applies to natural gas-fired internal combustion engines with uncontrolled NOx emissions greater than 10 tons per year.<br>Capital and annual cost information was obtained from model engine data in the Alternative Control Techniques (ACT) Document -- NOx Emissions from Stationary Reciprocating Internal Combustion Engines (EPA 1993c). | EPA 1993c, Pechan 2006 |
| Internal Combustion Engines - Gas | Ignition Retard | 20 | This control is the use of ignition retard technologies to reduce NOx emissions. This applies to small (<4,000 HP) natural gas-fired IC engines with uncontrolled NOx emissions greater than 10 tons per year. Capital and annual cost information was obtained from model engine data in the Alternative Control Techniques (ACT) Document - NOx Emissions from Stationary Reciprocating Internal Combustion Engines (EPA 1993c). | EPA 1993c, Pechan 1998a |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| Lean Burn ICE - NG | Layered Combustion | 97 | Layered combustion - for Large Bore, 2 stroke, Lean Burn, Slow Speed (High Pressure Fuel Injection achieves 90% reduction; Turbocharging achieves 75% reduction; Precombustion chambers achieves 90% reduction; Cylinder Head Modifications). All retrofit combustion- related controls may not be available for all manufacturers and models of 2-stroke lean burn engines. Actual NOx emission rates would be engine design specific. Efficiency achieved may range from 60 to 90%, depending on the make/model of engine (approximate range of NOx emissions of 3.0 to 0.5 g/bhp-hr). | OTC 2012, RTI 2014 |
| Lean Burn ICE - NG | Layered Combustion | 97 | Layered combustion - 2 stroke, Lean Burn, NG (Air Supply; Fuel Supply; Ignition; Electronic Controls; Engine Monitoring). Evaluation for 3 most representative made/models of 2 stroke LB compressor engines. All retrofit combustion-related controls may not be available for all manufacturers and models of 2-stroke lean burn engines. Actual NOx emission rates would be engine design specific. Efficiency achieved may range from 60 to 90%, depending on the make/model of engine (approximate range of NOx emissions of 3.0 to 0.5 g/bhp-hr). | OTC 2012, RTI 2014 |
| Lean Burn ICE - NG | Low Emission Combustion | 80 | Low Emission Combustion includes Precombustion chamber head and related equipment on a Lean Burn engine. | RTI 2014, SJVAPCD 2003, EPA 2018 |
| Industrial NG ICE, SCCs with technology not specified | Non-Selective Catalytic Reduction or Adjust Air Fuel Ratio and Ignition Retard | 39 | This control measure is for natural gas fired internal combustion engines where the firing technology is not specified as to Rich Burn or Lean Burn. Existing control measures are applied based on the estimated percentage of lean-burn engines (85%) and rich-burn engines (15%). Adjust Air to Fuel Ratio and Ignition Retard (NAFRIICGS) is used for lean-burn engines and NSCR (NNSCRINGI4) is used for rich-burn engines. | Pechan 2006, EPA 2007b, INGAA 2014, CSRA 2016 |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| Industrial NG ICE, 4cycle (rich) | Non-Selective Catalytic Reduction | 90 | NSCR is achieved by placing a catalyst in the exhaust stream of the engine. The exhaust passes over the catalyst, usually a noble metal (platinum, rhodium or palladium) which reduces the reactants to N2, CO2 and H20 (NJDEP 2003). Typical exhaust temperatures for effective removal of NOx are 800-1200 degrees Fahrenheit. An oxidation catalyst using additional air can be installed downstream of the NSCR catalyst for additional CO and VOC control. This includes 4-cycle naturally aspirated engines and some 4-cycle turbocharged engines. Engines operating with NSCR require air/fuel control to maintain high reduction effectiveness. | EPA 2007b, NJDEP 2003 |
| Industrial NG ICE, SCCs with technology not specified | Non-Selective Catalytic Reduction or Layered Combustion | 95.95 | This control measure is for natural gas fired internal combustion engines where the firing technology is not specified as to Rich Burn or Lean Burn. Existing control measures are applied based on the estimated percentage of lean-burn engines (85%) and rich-burn engines (15%). Layered combustion (NLCICE2SNG) is used for lean-burn engines and NSCR (NNSCRINGI4) is used for rich-burn engines. | EPA 2007b, OTC 2012, INGAA 2014, CSRA 2016 |
| Industrial NG ICE, SCCs with technology not specified | Non-Selective Catalytic Reduction or Low Emission Combustion | 87.45 | This control measure is for natural gas fired internal combustion engines where the firing technology is not specified as to Rich Burn or Lean Burn. Existing control measures are applied based on the estimated percentage of lean-burn engines (85%) and rich-burn engines (15%). Low emission combustion (NLECICEGAS) is used for lean-burn engines and NSCR (NNSCRINGI4) is used for rich-burn engines. | EPA 2007b, CARB 2001, INGAA 2014, CSRA 2016 |
| Lean Burn ICE - NG | Selective Catalytic Reduction | 90 | SCR can be used on Lean Burn, NG engines. Assumed SCR can meet NOx emissions of 0.89 g/bh-hr. This is a known technology, however there is indication that applicability is engine/unit specific. | OTC 2012, SJVAPCD 2003, CARB 2001, EPA 2018, RTI 2014 |

Reproduced from EPA, Menu of Control Measures for NAAQS Implementation, available at https://www.epa.gov/air-quality-implementation-plans/menu-control-measures-naaqs-implementation (URL dated January 13, 2023).

**Applicability Requirements**

EPA received comments requesting a clarification of the meaning of "pipeline transportation of natural gas." EPA is clarifying and narrowing the definition of "pipeline transportation of natural gas" to mean the transport or storage of natural gas prior to delivery to a local distribution company custody transfer station or to a final end-user (if there is no local distribution company custody transfer station). The revised definition of this term in § 52.41(a) is consistent with EPA's regulatory definition of "natural gas transmission and storage segment" in 40 CFR 60.5430(a) (Subpart OOOOa, Standards of Performance for Crude Oil and Natural Gas Facilities for Which Construction, Modification, or Reconstruction Commenced After September 18, 2015).

EPA is adding definitions of the terms "local distribution company" and "local distribution company custody transfer station" that are consistent with the definitions found in 40 CFR 98.400 (Subpart NN, Suppliers of Natural Gas and Natural Gas Liquids) and 40 CFR 60.5430(a) (Subpart OOOOa, Standards of Performance for Crude Oil and Natural Gas Facilities for Which Construction, Modification, or Reconstruction Commenced After September 18, 2015), respectively.

Commenters stated that emergency generators are currently exempt from requirements applicable to non-emergency RICE covered by both the relevant NSPS rule (Subpart JJJJ), as well as the relevant NESHAP rule (Subpart ZZZZ), and that although the NSPS and NESHAP standards EPA has adopted for emergency RICE do not limit the amount of time they may run for emergency purposes, EPA has recognized in the past that states may assume a maximum of 500 hours of operation to estimate the "potential to emit" in issuing air permits for emergency RICE. Following a review of comments, EPA is finalizing an exemption for emergency engines. "Emergency engine" is defined to mean any stationary reciprocating internal combustion engine that is operated to provide electrical power or mechanical work during an emergency situation. Examples include stationary RICE used to produce power for critical networks or equipment (including power supplied to portions of a facility) when electric power from the local utility (or the normal power source, if the facility runs on its own power production) is interrupted, or stationary RICE used to pump water in the case of fire or flood, etc. Under the provisions of this rule, facilities may operate their emergency stationary RICE for limited non-emergency purposes for a maximum of 100 hours per calendar year.

**Emission Limits and Compliance Requirements**

In setting the emission limits for the Pipeline Transportation of Natural Gas, EPA reviewed state and local air agency rules, RACT NOx rules, NSPS rules applicable to newer engines, active air permits issues to sources with similar engines and the feasibility of $NO_X$ reductions analyzed in the OTC Engine Study. While some permits and rules reviewed express engine emissions limits in parts per million by volume (ppmv), the majority of rules and source-specific requirements express the emissions limits in grams per horsepower per hour (g/hp-hr). Based on the available information for this industry, EPA is finalizing the following emissions limits expressed in terms of g/hp-hr for stationary SI engines in the covered states. Beginning in the 2026 ozone season and in each ozone season thereafter, the NOx emissions limits shown in the following table apply, based on a 30-day rolling average emissions rate during the ozone season:

**Table 2.B: Final NOX Emissions Limits**

| Engine Type and Fuel | Final $NO_X$ Emissions Limit |
|---|---|
| Natural Gas Fired Four Stroke Rich Burn | 1.0 g/hp-hr |
| Natural Gas Fired Four Stroke Lean Burn | 1.5 g/hp-hr |
| Natural Gas Fired Two Stroke Lean Burn | 3.0 g/hp-hr |

Generally, the emission limits in Table 2.B can be met through installation and operation of the following controls: 1) NSCR on four stroke rich burn engines; 2) SCR on four stroke lean burn engines; and 3) layered combustion on two stroke lean burn engines.

In response to industry concern about the number of units captured by the proposed applicability criteria, EPA has made several changes to the applicability criteria as noted above in the *Applicability Requirements* subsection and to the emissions limits requirements in the final rule to focus the control requirements on impactful non-EGU units. Based upon EPA's 2019 NEI emissions inventory data, EPA estimates that a total of 3,005 stationary SI engines are subject to the final rule. EPA recognizes that many low-use engines are captured by the 1,000 hp design capacity applicability threshold.

Several commenters raised concerns about the proposed rule and asserted that compliance flexibility should be allowed where the installation of NOx controls is infeasible or cost-ineffective. Commenters recommended that EPA promulgate emissions averaging provisions as a remedy, as it promulgated in the 2004 NOX SIP Call Phase 2 rule, in which EPA evaluated and supported reliance on emissions averaging for RICE in the Pipeline Transportation of Natural Gas industry sector.

EPA reviewed past EPA guidance and rulemaking in which averaging plans were considered or recommended. In 1998, EPA issued the NOx SIP Call requiring certain states to reduce their NOx emissions as a means to reduce interstate ozone pollution. In 2002, EPA issued a memorandum providing guidance to the States that chose to adopt rules covering stationary RICE as part of their response to the 1998 NOx SIP Call.[20] This memo encouraged flexibility for RICE owners/operators in terms of their choices of control technology and the size of engines to be controlled, so long as each state's total budget was met. While EPA did not promulgate averaging provisions in the 2004 NOx SIP Call Phase 2 rule, we referred back to the 2002 Wegman memorandum and again noted that states that chose to regulate IC engines were encouraged to consider such flexibilities, so long as it could be demonstrated that the control measures in the SIP are collectively adequate to comply with the state's $NO_X$ budget. *See* 69 FR

[20] Memorandum: "State Implementation Plan (SIP) Call for Reducing Nitrogen Oxides (NOx) –Stationary Reciprocating Internal Combustion Engines", L. Wegman, US EPA OAQPS, August 22, 2002.

at 21621. The 2002 memorandum and the 2004 NOx SIP Call Phase 2 rule provide a backdrop for existing state rules allowing facility-wide averaging of NOx emissions.

EPA conducted research into several states' air quality rules containing emissions averaging plan provisions to review potential models using existing regulatory frameworks and methodologies. EPA considered relevant regulations in Colorado, Illinois, Michigan, New Jersey, New Mexico, Oklahoma, Pennsylvania, Tennessee, and Wisconsin.

The table below summarizes state provisions that allow for NOx emissions averaging. As indicated in the second column, nearly all of these provisions address emissions averaging across all RICE addressed by that State's regulations. The exception is for Texas, which allows for averaging required NOx reductions for grandfathered RICE in natural gas gathering and transmission. In the table, the "Facility Definition(s)" column summarizes key differences among the states in how a "facility" is represented in the averaging plan. Key differences in state rules include:

- Whether units allowed to be averaged are within a single facility or whether multiple facilities can be averaged (e.g., a "system-wide averaging plan");
- If multiple facilities can be addressed with a single plan:
  - Geographic limitations: for example, only units at facilities within the same ozone nonattainment area (NAA) can be included in the same plan
  - Control over operation of emissions units: most states require that all emission units be under common operational control;
- Emissions units for inclusion in a state plan: most state plans did not specify whether only affected (e.g., State RACT) units were to be included in the plan or if non-affected units could also be included. Ohio's approach provides for both affected and non-affected units to be included.
- Most states allow units to be excluded from the averaging plan, if they are otherwise compliant with the applicable defined RACT limit for that source.

The fifth column of Table 1 summarizes the specifications for NOx emissions averaging. This includes whether ozone season limitations are involved, or if annual limits are also required. For ozone season emissions, we also evaluated whether these are measured on a total seasonal basis (e.g. tons per ozone season) or on an average ozone season daily basis (e.g., on a rolling 30-day average).

The final column of the table shows exemptions for certain types of RICE. Note that these are exemptions from State NOx emissions rules, rather than exemptions from averaging plan programs.

**Table 2.C. Existing State Regulations Containing Facility Averaging Plan Provisions for RICE NOx Reductions**

| State | RICE Coverage; Citation[a] | Affected Natural Gas RICE Units | Facility Definition(s) | Form of NOx Cap | Unit Exemptions |
|---|---|---|---|---|---|
| IL | All; Ill. Admin. Code title 35, § 217.386-390 | • RICE =/>500 bhp | • Units at single "sources" (PTE>100 tpy NOx) or multiple "sources" under common control; Chicago area counties<br>• Specified RICE, mainly pipeline units statewide | • Ozone season tons<br>• Calendar year tons | • Emergency/Standby<br>• Research, landfill gas, agricultural purpose<br>• Nonstationary and <1,500 bhp |
| LA | All; Title 33, Chapter 22, § 2201 | • Baton Rouge NAA: Rich and lean burn =/>150 bhp<br>• NAA region of influence: lean burn =/>1500 bhp; rich burn =/>300 bhp | • Units at single facilities (PTE>25 tpy NOx) in the Baton Rouge NAA or (PTE>/= 50 tpy) in the NAA region of influence<br>• Units located in multiple NAA or region of influence under common control | • OSD daily; 30 day rolling average, or<br>• Ozone season lb/hr cap | • Emergency/Standby<br>• Research, landfill gas, agricultural purpose, performance/ verification testing<br>• Firefighting training<br>• Flood control<br>• Use for powering other engines |
| MI | All; R 36.1818 | • "Large NOx SIP Call Engines": >1 ton per average OSD in 1995 | • Units at single facilities or multiple facilities in the MI fine grid zone under common control | • </= total 2007 ozone season NOx | • None specified |
| NJ | All; N.J.A.C. 7:27-19 | • Rich or lean burn >500 bhp<br>• Lean burn >200 and <500 bhp | • No specifications provided for averaging units in separate facilities | • OSD daily actual < allowable<br>• Non-OSD monthly actual < allowable | • None specified |

| State | RICE Coverage; Citation[a] | Affected Natural Gas RICE Units | Facility Definition(s) | Form of NOx Cap | Unit Exemptions |
|---|---|---|---|---|---|
| NY | All; 6 NYCRR § 227-2.5 | • RICE >200 bhp inside severe ozone NAA<br>• RICE >400 bhp outside severe ozone NAA | • Referred to as a "system." Multiple emission sources at different facilities in the same ozone NAA can be included in the system averaging plan.<br>• Can include multiple owners/ operators | • Maintain "weighted average permissible emissions rate" from the plan. | • Emergency generators<br>• Research and development or quality assurance testing |
| OH | All; Ohio Admin. Code 3745-110-03(I) | • RICE >500 bhp | • No specification for operational control<br>• Affected and non-affected sources can be included | • Actual NOx tpy < allowable NOx tpy | • Engine testing operations<br>• Permitted units with permitted restrictions resulting in <25 tpy NOx<br>• Affected units with capacity factors of <10% annually during a 3-yr rolling average |
| OK | All; OAC Title 252, Chapter 100, Subchapter 11 | • All fuel burning equipment >50 MMBtu/hr | • Multiple facilities can be included which are on adjacent properties and affect the same airshed<br>• Multiple facilities must be under control of the same owner or operator | • Actual NOx emissions < allowable NOx, no averaging time specified | • None specified |
| PA | All; PA Title 25, § 129 | • RICE >500 bhp | • Multiple units at a facility can be included or units at multiple facilities for system-wide averaging<br>• Facilities within a system must be within the same NAA<br>• Facilities must be under control of the same owner or operator | • Actual NOx emissions </= allowable NOx, 30-day rolling average | • Units with PTE <1 tpy NOx |

| State | RICE Coverage; Citation[a] | Affected Natural Gas RICE Units | Facility Definition(s) | Form of NOx Cap | Unit Exemptions |
|---|---|---|---|---|---|
| | | | • Each unit must be subject to a NOx RACT emissions limit | | |
| TX | Natural gas gathering or transmission RICE; 30 TAC §116.779(b)(3) | • All grandfathered RICE | • Specific provisions provided for grandfathered RICE used in natural gas gathering and transmission; allows averaging of required NOx reduction across units (50% east TX region; 20% west TX region<br>• Averaging of reductions across east and west TX regions; but reductions achieved in east region must =/> required reductions | • Actual NOx emissions < allowable NOx, no averaging time specified | • None specified |
| VA | All: 9VAC5, Chapter 40, §§ 7370 – 7540 | • RICE >/=450 bhp | • No specifications for averaging plans are present; but since RACT for RICE NOx limitations are not specified, a case-specific plan is required. Conceivably, that plan could include an averaging approach. | • Actual NOx emissions < allowable NOx, no averaging time specified | • Emergency generators |
| WI | All; Wis. Adm. Code Chapter NR 428, § 428.25 (1) | • RICE =/>1000 bhp | • Multiple units at one facility can be included as well as averaging across facilities<br>• Multiple owners/operators can be included | • Actual ozone season NOx < Allowable ozone season NOx<br>• Actual annual NOx < Allowable annual NOx | • Units used to restart electricity generating units; Fire emergency water pumps; research & development units; engine testing<br>• Backup generators operating <500 hours/yr or <200 hours during the ozone season |

| State | RICE Coverage; Citation[a] | Affected Natural Gas RICE Units | Facility Definition(s) | Form of NOx Cap | Unit Exemptions |
|---|---|---|---|---|---|
| | | | | | • <10% annual capacity factor, 3-yr rolling basis or <20% for utility owned engines |

Abbreviations: bhp – brake horse-power; MMBtu/hr – million British thermal units per hour; MW – megawatt; NAA – nonattainment area; OSD – ozone season day; PTE – potential to emit; RICE – reciprocating internal combustion engine; tpy – tons per year

[a]Weblinks to state regulatory text:

IL: https://pcb.illinois.gov/documents/dsweb/Get/Document-11928/ (URL dated February 6, 2023).
LA: https://deq.louisiana.gov/assets/docs/Air/Enforcement/Title33.pdf (URL dated February 6, 2023).
MI: https://www.michigan.gov/-/media/Project/Websites/egle/Documents/Laws-Rules/AQD/apc-part8-2009-05-28-amended.pdf?rev=9194185cf0f7489e83c8c906be6bbea8 (URL dated February 6, 2023).
NJ: https://www.nj.gov/dep/aqm/currentrules/Sub19.pdf (URL dated February 6, 2023).
NY: https://www.dec.ny.gov/regs/2492.html (URL dated February 6, 2023).
OH: https://codes.ohio.gov/ohio-administrative-code/rule-3745-110-03 (URL dated February 6, 2023).
OK: https://www.deq.ok.gov/wp-content/uploads/deqmainresources/100.pdf (URL dated February 6, 2023).
PA: http://www.pacodeandbulletin.gov/Display/pacode?file=/secure/pacode/data/025/chapter129/s129.98.html&d=reduce (URL dated February 6, 2023).
TX: https://www.tceq.texas.gov/assets/public/legal/rules/rules/pdflib/116h.pdf (URL dated February 6, 2023).
VA: https://www.deq.virginia.gov/home/showpublisheddocument/4168/637461452622230000 (URL dated February 6, 2023).
WI: https://docs.legis.wisconsin.gov/code/admin_code/nr/400/428.pdf (URL dated February 6, 2023).

EPA conducted an analysis to evaluate the anticipated effect of a facility-wide emissions averaging compliance alternative. To estimate the number of facilities that may take advantage of the Facility-Wide Averaging Plan provisions, and the number of affected units that would install controls under such an emissions averaging plan, EPA conducted an analysis on a subset of the estimated 3,005 stationary IC engines subject to the final rule. EPA evaluated the reported actual $NO_X$ emissions data in tpy from a subset of facilities in the covered states using 2019 NEI data for stationary IC engines with design capacities of 1,000 hp or greater. Using this subset of facilities, EPA then identified a number of facilities that have more than one affected engine, calculated each facility's emissions "cap" as the total $NO_X$ emissions (in tons per year (tpy)) allowed facility-wide based on the unit-specific $NO_X$ emissions limits applicable to all affected units at the facility, and identified a number of higher-emitting engines at each facility that were candidates for having controls installed. For engines that EPA identified were likely to install controls, EPA assumed that four stroke rich burn engines, four stroke lean burn engines, and two stroke lean burn engines could achieve a $NO_X$ emissions rate of 0.5 g/hp-hr with the installation of SCR based on data obtained from the Ozone Transport Commission report entitled *Technical Information Oil and Gas Sector Significant Stationary Sources of $NO_X$ Emissions* (October 17, 2012). For the remaining engines identified as uncontrolled, EPA assumed a $NO_X$ emissions rate of 16 g/hp-hr for all engine types. Thus, under the assumed averaging scenarios, engines with controls installed would achieve emissions levels below the emissions limits in the final rule and would offset the higher emissions from the remaining uncontrolled units. EPA then calculated the total facility-wide emissions (in tpy) under various assumed averaging scenarios and compared those totals to each facility's calculated emissions cap (in tpy) to estimate the number of affected units at each facility that would need to install controls to ensure that total facility-wide emissions remained below the emissions cap.

For each facility in the subset, the next step in the analysis was to determine the average of the actual 2019 NEI emissions (tpy) of only engines for which no controls had been applied in the previous cap compliance step. The average actual 2019 emissions (tpy) for facilities in this subset was found to be 21 tpy $NO_X$ emissions. The next step in the analysis was to apply the 21 tpy uncontrolled emissions (tpy) threshold to the entire estimated 3,005 stationary IC engines subject to the rule. The application of this threshold to the engines subject to the final rule determined the estimated number of affected engines that would be expected to have controls installed under a facility-wide emissions averaging plan scenario. Based on this analysis, EPA found that emissions averaging should allow most facilities to install controls on approximately one-third of the engines at their sites, on average, while complying with the applicable $NO_X$ emissions cap on a facility-wide basis.

Following a review of public comments and evaluating the results of the analysis conducted, EPA is finalizing a facility-level emissions averaging provision as an alternative means of compliance with the emissions limits established in § 52.41(c). The requirements that we are finalizing for engines in the Pipeline Transportation of Natural Gas industry include provisions allowing source owner/operators to request EPA approval of facility-wide emissions averaging plans, which will enable owners and operators of affected units to take costs, installation timing needs, and other considerations into account in deciding which affected engines to control. Facility-wide emissions averaging plans will allow facility owners and operators to determine how to best achieve the necessary emissions reductions by installing controls on the affected engines with the greatest emissions reduction potential rather than on units with lower actual emissions where the installation of controls would be less cost effective.

An owner or operator of a facility containing more than one affected unit may elect to use an EPA-approved Facility-Wide Averaging Plan as an alternative means of compliance with the $NO_X$ emissions limits in § 52.41(c). An approved Facility-Wide Averaging Plan will allow the owner or operator of the facility to average emissions across all participating units and thus to select the most cost-effective means for installing the necessary controls (i.e., by installing controls on the subset of engines that provide the greatest emissions reduction potential at lowest costs and avoiding installation of controls on equipment that is infrequently operated or otherwise less cost-effective to control). So long as all of the emissions units covered by the Facility-Wide Averaging Plan collectively emit less than or equal to the total amount that would be emitted if each covered unit individually met the applicable $NO_X$ emissions limitations, the covered units will be in compliance with the final rule. Under this alternative compliance option, facilities have the flexibility to prioritize emissions reductions from larger, dirtier engines.

The owner or operator of such a facility that elects to use a facility-wide emissions averaging plan must submit a request to EPA that, among other things, specifies the affected units that will be covered by the plan, provides facility and unit-level identification information, identifies a facility-wide emissions “cap” (in tpd) that the facility must comply with on a 30-day rolling average basis, and provides the calculation methodology used to demonstrate compliance with the identified emissions cap. The final rule defines “cap” to mean “the total amount of NOx emissions, in tons per day on a 30-day rolling average basis, that is collectively allowed from all of the affected units covered by a Facility-Wide Averaging Plan and is calculated as the sum each affected unit’s NOx emissions at the emissions limit applicable to such unit under paragraph (c) of this section, converted to tons per day in accordance with [section 52.41(d)(3)].” The calculation of a facility’s emissions “cap” is based in part on each affected unit’s average daily operating hours. EPA will approve a request for a Facility-Wide Averaging Plan if EPA determines that the facility-wide emissions total (in tpd), based on a 30-day rolling emissions average basis during the ozone season, is less than the emissions cap (in tpd) and the plan establishes satisfactory means for determining initial and continuous compliance, including appropriate testing, monitoring, recordkeeping requirements. In calculating the facility-wide emissions total during the ozone season, affected engines covered by the Facility-Wide Averaging Plan must be identified by each engine’s nameplate capacity in horsepower, its actual operating hours during the ozone season, and its emissions rates in g/hp-hr from certified engine data or from the most recent performance test results for non-certified engines according to § 52.41(e). For affected engines that meet the certification requirements of § 60.4243(a), the facility-wide emissions calculations may be based on certified engine emissions standards data pursuant to § 60.4243(a), instead of performance tests. An affected unit listed in an EPA-approved Facility-Wide Averaging Plan cannot be withdrawn from such plan, and the terms of an approved Facility-Wide Averaging Plan may not be changed unless approved in writing by the Administrator.

**Performance Tests and Monitoring**

Affected units subject to this rule that operate $NO_x$ CEMS meeting specified requirements may use CEMS data to demonstrate compliance.

With respect to affected units that do not operate CEMS, EPA received comments concerning the proposed semi-annual $NO_x$ performance testing to demonstrate continual compliance. As commenters pointed out, the emissions limits in these final FIPs only apply during the ozone season and testing once per calendar year should be sufficient to confirm the accuracy of the parameters being monitored to demonstrate continuous compliance during the ozone season. The final rule contains provisions requiring owners and operators of affected units that do not operate CEMS to conduct annual $NO_X$ performance tests, to monitor and record hours of operation and fuel consumption, and to use continuous parametric monitoring systems to demonstrate ongoing compliance with the applicable $NO_X$ emissions limits. To avoid challenges in scheduling and availability of testing firms, the annual performance tests do not have to be conducted during the ozone season. Owners and operators of affected units must also reassess and adjust the site-specific operating parameters in accordance with the results of each performance test, and report and include ongoing site-specific operating parameter data in the annual reports to EPA and the semi-annual title V monitoring reports to the relevant air permitting authority.

# 3 Cement and Concrete Product Manufacturing

**Process Description**[21]

Cement kilns are used by the cement industry in the production of cement. Portland cement, used in almost all construction applications, is the industry's primary product. Essentially all of the NOx emissions associated with cement manufacturing are generated in the kilns because of high process temperatures.

Detailed information describing cement production can be found in Section 3 of the TSD to the proposal and is not repeated here.

**Federal Rules Affecting Cement Plants**

Cement plants are subject to the Portland Cement NESHAP (40 CFR part 63 subpart LLL) and NSPS (40 CFR part 60, subpart F). Cement kilns that burn hazardous waste are subject to the Hazardous Waste Combustor NESHAP (40 CFR part 63 subpart LLL). Cement kilns that burn non-hazardous solid wastes are subject to the Commercial and Industrial Solid Waste Incinerator Units (CISWI) rule (40 CFR part 60, subparts CCCC and DDDD).

The NSPS implementing Clean Air Act (CAA) section 111(b) for Portland Cement Plants was first promulgated at 40 CFR part 60, subpart F on December 23, 1971 (36 FR 24876). EPA conducted three additional reviews of these standards on June 14, 1974 (39 FR 20793), November 12, 1974 (39 FR 39874) and December 14, 1988 (53 FR 50354). NOx emissions were not regulated under part 60, subpart F at that time.

On June 16, 2008 (73 FR 34072), EPA proposed amendments to the NSPS for Portland Cement Plants. The proposed amendments included revisions to the emission limits for affected facilities which commence construction, modification, or reconstruction after June 16, 2008. Among other things, EPA proposed establishing a NOx emission limit for cement kilns at portland cement plants.[22]

On September 9, 2010 (75 FR 54970) EPA finalized the proposed amendments to the NSPS establishing a NOx emission limit, among other things, for portland cement plants that commence construction, modification, or reconstruction after June 16, 2008. This final rule became effective on November 8, 2010 and is codified at 40 CFR part 60 subpart F.

**NOx Controls**

The National Association of Clean Air Agencies (NACAA, formerly STAPPA/ALAPCO) has recommended requiring combustion controls and selective non-catalytic reduction (SNCR) to achieve NOx reductions of up to 70 percent on certain processes at

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[21] See generally EPA, "AP-42 Compilation of Air Emissions Factors," Chapter 11, Mineral Products Industry, Section 11.6, Portland Cement Manufacturing, Final Section (January 1995).
[22] 73 FR 34072 (proposed NSPS for Portland Cement Plants), Docket IN No. EPA–HQ–OAR–2007–0877.

cement kilns.[23] SNCR is a post combustion control technology used to reduce NOx emissions without the presence of a catalyst. Reagent (Ammonia or Urea) is injected directly into flue gas and reacts with NOx resulting in Nitrogen ($N_2$) and water ($H_2O$).

SNCR avoids the problems related to catalyst fouling that occur during use of SCR technology but requires injection of the reagents in the kiln at a temperature between 1600 to 2000°F, which is much higher than the typical temperatures for SCR operation (550-800°F). At these temperatures urea decomposes to produce ammonia which is responsible for NOx reduction. Because of the temperature constraint, SNCR technology is only applicable to preheater and precalciner kilns.[24] Preheater and precalciner kilns require relatively simple SNCR installations. In preheater/precalciner kiln design, the SNCR injection ports can be installed in the combustion zone in the calciner, the oxidation zone of the upper air inlet before the deflection chamber, or in the area after the mixing chamber before the inlet to the bottom. SNCR has been installed and is currently operating on numerous kilns in Europe and the U.S.

SCR is a process that uses ammonia in the presence of a catalyst to selectively reduce NOx emissions from exhaust gases. This technology was at first widely used for NOx abatement in other industries, such as coal-fired power stations and waste incinerators. In SCR, anhydrous ammonia, usually diluted with air or steam, is injected through a grid system into hot flue gases which are then passed through a catalyst bed to carry out NOx reduction reactions. Ammonia is typically injected to produce a $NH_3$ to NOx molar ratio of 1.05-1.1:1 to achieve a NOx conversion of 80 to 90 percent with an ammonia "slip" of about 10 ppm of unreacted ammonia in the gases leaving the reactor. In the cement industry, basically two SCR systems are being considered: low dust exhaust gas and high dust exhaust gas treatment. Low dust exhaust gas systems require reheating of the exhaust gases after dedusting, resulting in additional cost. High dust systems are considered preferable for technical and economical reasons.[25] While SCR installations are not common at cement kilns in the U.S, EPA is aware of one SCR system that has been installed on a cement kiln in Joppa, Illinois.[26]

The European Union Commission charged with establishing the Best Available Techniques (BAT) to control NOx emissions from the production of cement outlines the following control techniques presented in Table 3.A below.

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[23] STAPPA/ALAPCO, Controlling Nitrogen Oxides Under the Clean Air Act: A Menu of Options, 72-73 (July 1994).
[24] EPA, NOx Control Technologies for the Cement Industry: Final Report, 6 (September 2000).
[25] Official Journal of European Union Commission, Best Available Techniques (BAT) Conclusions Under Directive 2010/75/EU of the European Parliament and of the Council on Industrial Emissions for the Production of Cement, Lime and Magnesium Oxide, March 26, 2013, at 42.
[26] State of Illinois Clean Air Act Program Permit No. 95090119 (issued September 11, 2018, to Holcim US, Inc. - Joppa Plant, 2500 Portland Road, Grand Chain, IL 62941), Section 4.1 Cement Kilns and Clinker Coolers, Kiln #1. See also Lafarge, North America, Inc., Clean Air Act Settlement (overview of injunctive relief, available at https://www.epa.gov/enforcement/lafarge-north-america-inc-clean-air-act-settlement (URL dated October 12, 2021)).

**Table 3.A: European Union Commission NOX BAT Controls**

| Primary Techniques/Measures | Description |
|---|---|
| Flame Cooling | The addition of water to the fuel or directly to the flame by using different injection methods, such as injection of one fluid (liquid) or two fluids (liquid and compressed air or solids) or the use of liquid/solid wastes with a high water content reduces the temperature and increases the concentration of hydroxyl radicals. This can have a positive effect on NOx reduction in the burning zone. |
| Low NOx Burners | Designs of low NOx burners (indirect firing) vary in detail but essentially the fuel and air are injected into the kiln through concentric tubes. The primary air proportion is reduced to some 6 - 10% of that required for stoichiometric combustion (typically 10 - 15% in traditional burners). Axial air is injected at high momentum in the outer channel. The coal may be blown through the center pipe or the middle channel. A third channel is used for swirl air, its swirl being induced by vanes at, or behind, the outlet of the firing pipe. The net effect of this burner design is to produce very early ignition, especially of the volatile compounds in the fuel, in an oxygen-deficient atmosphere, and this will tend to reduce the formation of NOx. The application of low NOx burners is not always followed by a reduction of NOx emissions. The set-up of the burner has to be optimized. |
| Mid Kiln Firing | In long wet and long dry kilns, the creation of a reducing zone by firing lump fuel can reduce NOx emissions. As long kilns usually have no access to a temperature zone of about 900 -1000°C, mid-kiln firing systems can be installed in order to be able to use waste fuels that cannot pass the main burner (for example tires). The rate of the burning of fuels can be critical. If it is too slow, reducing conditions can occur in the burning zone, which may severely affect product quality. If it is too high, the kiln chain section can be overheated - resulting in the chains being burned out. A temperature range of less than 1100°C excludes the use of hazardous waste with a chlorine content of greater than 1%. |
| Addition of mineralizers to improve the burnability of the raw meal (mineralized clinker) | The addition of mineralizers, such as fluorine, to the raw material is a technique to adjust the clinker quality and allow the sintering zone temperature to be reduced. By reducing/lowering the burning temperature, NOx formation is also reduced. |
| Staged combustion (conventional or waste fuels), also in combination | Staged combustion is applied at cement kilns with an especially designed precalciner. The first combustion stage takes place in the rotary kiln under optimum conditions for the clinker burning process. The second combustion stage is a burner at the kiln inlet, which produces a reducing |

| **Primary Techniques/Measures** | **Description** |
|---|---|
| with a precalciner and the use of optimized fuel mix | atmosphere that decomposes a portion of the nitrogen oxides generated in the sintering zone. The high temperature in this zone is particularly favorable for the reaction which reconverts the NOx to elementary nitrogen. In the third combustion stage, the calcining fuel is fed into the calciner with an amount of tertiary air, producing a reducing atmosphere there, too. This system reduces the generation of NOx from the fuel, and also decreases the NOx coming out of the kiln. In the fourth and final combustion stage, the remaining tertiary air is fed into the system as 'top air' for residual combustion. |
| SNCR | Selective non-catalytic reduction (SNCR) involves injecting ammonia water (up to 25% $NH_3$), ammonia precursor compounds or urea solution into the combustion gas to reduce NO to $N_2$. The reaction has an optimum effect in a temperature window of about 830 - 1050°C, and sufficient retention time must be provided for the injected agents to react with NO. |
| SCR | SCR reduces NO and $NO_2$ to Nitrogen with the help of $NH_3$ and a catalyst at a temperature range of 300 - 400°C. This technique was initially started for NOx abatement in other industries (coal fired power stations, waste incinerators) and is now available in the cement manufacturing industry. |

Reproduced from Official Journal of European Union Commission, Best Available Techniques (BAT) Conclusions Under Directive 2010/75/EU of the European Parliament and of the Council on Industrial Emissions for the Production of Cement, Lime and Magnesium Oxide, March 26, 2013, Table 1.5.2.

EPA's Menu of Control Measures (MCM) provides state, local and tribal air agencies with information on existing criteria pollutant emission reduction measures as well as relevant information concerning the efficiency and cost effectiveness of the measures.[27] State, local, and tribal agencies may use this information in developing emission reduction strategies, plans and programs to assure they attain and maintain the NAAQS. The information from the MCM can also be found in the Control Measures Database (CMDB), a major input to the Control Strategy Tool (CoST), which EPA used in the NOx control strategy analysis included in the Non-EGU Screening Assessment memorandum.[28] Information about control measures to reduce NOx emissions from cement kiln operations is presented in Table 3.B below.

[27] EPA, Menu of Control Measures for NAAQS Implementation, available at https://www.epa.gov/air-quality-implementation-plans/menu-control-measures-naaqs-implementation (URL dated January 5, 2022).
[28] EPA, Control Measures Database (CMDB) for Stationary Sources, available at https://www.epa.gov/system/files/other-files/2021-09/cmdb_2021-09-02_0.zip (URL dated January 6, 2022).

**Table 3.B: List of $NO_X$ Controls Available for Cement Kilns**

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| Cement kilns | Biosolid Injection Technology | 23 | This control is the use of biosolid injection to reduce NOx emissions. This control applies to cement kilns. | EPA 2006b, EPA 2007c |
| Cement kilns | Changing feed composition | 25-40 | This control is changing the cement formulation by adding steel slag to lower the clinkering temperatures and suppress NOx. The patented feed modification technique known as the CemStar Process is a raw feed modification process that can reduce NOx emissions by about 30 percent and increase production by approximately 15 percent. It involves the addition of a small amount of steel slag to the raw kiln feed. Steel slag has a chemical composition similar to clinker and many of the chemical reactions required to convert steel slag to clinker take place in the steel furnace. By substituting steel slag for a portion of the raw materials, facilities can increase thermal efficiency and thereby reduce NOx emissions. This control is applicable to wet- and dry-process kilns, as well as those with preheaters or precalciners. | STAPPA/ALAPCO 2006 |
| Cement Kilns | Process Control Systems | <25 | This control is the modification of the cement production process to improve fuel efficiency, increase capacity and kiln operational stability. NOx reductions result from the increase in productivity and reduced energy use. One process control that specifically targets NOx emissions is continuous emissions monitoring systems (CEMS). CEMS allow operators to continuously monitor oxygen and carbon monoxide (CO) emissions in cement kiln exhaust gases. The levels of these gases indicate the amount of | STAPPA/ALAPCO 2006 |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
| --- | --- | --- | --- | --- |
| | | | excess air in the combustion zone. At a given excess air level, NOx emissions increase as the temperature increases. Knowing the excess air level allows operators to maintain a lower temperature and thereby minimize NOx creation. Studies indicate that reducing excess air by half can reduce NOx emissions by about 15 percent. This control is applicable to wet- and dry-process kilns, as well as those with preheaters or precalciners. | |
| Cement Manufacturing - Dry Process | Selective Non-Catalytic Reduction - Ammonia | 50 | This control is the reduction of NOx emission through ammonia based selective non-catalytic reduction add-on controls. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen ($N_2$) and water vapor ($H_2O$). This control applies to dry-process cement manufacturing operations with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994h |
| Cement Manufacturing - Dry Process | Selective Non-Catalytic Reduction – Urea | 50 | This control is the reduction of NOx emission through urea based selective non-catalytic reduction add-on controls. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen ($N_2$) and water vapor ($H_2O$). This control applies to dry-process cement manufacturing with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, EPA 1998e, EPA 2002a, EPA 1994h |
| Cement Manufacturing - Dry Process or Wet Process | Low NOx Burner | 25 | This control is the use of low NOx burner (LNB) technology to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering the temperature of | EPA 2006b, EPA 1998e, EPA 2002a, EPA 1994h, EC/R 2000 |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| | | | one combustion zone and reducing the amount of oxygen available in another. This control applies to dry-process or wet-process cement manufacturing operations with indirect-fired kilns with uncontrolled NOx emissions greater than 10 tons per year. | |
| Cement Manufacturing - Dry Process or Wet Process | Mid-Kiln Firing | 30 | This control is the use of mid-kiln firing to reduce NOx emissions. Mid-kiln firing is the injection of solid fuel into the calcining zone of a long kiln. This allows for part of the fuel to be burned at a lower temperature, reducing NOx formation. This control applies to wet-process and dry-process cement manufacturing operations with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, EPA 1998e, EPA 2002a, EPA 1994h, EC/R 2000 |
| Cement Manufacturing - Wet Process | Selective Catalytic Reduction | 90 | This control is the selective catalytic reduction of NOx through add-on controls. SCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). The SCR utilizes a catalyst to increase the NOx removal efficiency, which allows the process to occur at lower temperatures. This control applies to wet-process cement manufacturing with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2007b |

Reproduced from EPA, Menu of Control Measures for NAAQS Implementation, available at https://www.epa.gov/air-quality-implementation-plans/menu-control-measures-naaqs-implementation (URL dated January 5, 2022).

Table 3.C below presents NOx control techniques and the types of kilns on which they may be applied.[29]

**Table 3.C: NOX Controls Available for Each Cement Kiln Type**

| **NOx Control Technique** | **Applicable Kiln Type** | | | |
|---|---|---|---|---|
| | Long Wet | Long Dry | Preheater | Precalciner |
| Process Control Systems | Yes | Yes | yes | yes |
| CemStar | Yes | Yes | yes | yes |
| Low-NOx Burner [a] | Yes | Yes | yes | yes |
| Mid-Kiln Firing | Yes | Yes | no | no |
| Tire Derived Fuel [b] | Yes | Yes | yes | yes |
| SNCR | No | No | yes | yes |

[a] Low-NOx burners can only be used on kilns that have indirect firing.
[b] Tire derived fuel can be introduced mid-kiln in a wet or long-dry kiln, or at the feed end of a preheater or precalciner kiln.
Reproduced from EPA, "NOx Control Technologies for the Cement Industry, Final Report," EPA-457/R-00-002 (September 2000), at 76.

### State RACT Rules

EPA reviewed information provided in a SIP submission from the Texas Commission on Environmental Quality (TCEQ) concerning NOx control technologies that have been implemented at portland cement plants.[30]

- Texas, Ellis County -Three companies currently operate four kilns in Midlothian, Ellis County. Since 2015, no cement plant is using wet kilns.

- Ash Grove Cement Company (Ash Grove) operated three kilns in Ellis County. However, a 2013 consent decree with EPA required by September 10, 2014 shutdown of two kilns and reconstruction of kiln #3 with SNCR with an emission limit of 1.5 pounds of NOx per ton of clinker and a 12-month rolling tonnage limit for NOx of 975 tpy. The reconstructed kiln is a dry kiln with year-round SNCR operation and is subject to the 1.5 lb NOx/ton of clinker emission standards in the NSPS for Portland Cement Plants. EPA has delegated authority to enforce this NSPS to the TCEQ and the NSPS satisfies RACT for Ash Grove.[31]

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[29] EPA, "NOx Control Technologies for the Cement Industry, Final Report," EPA-457/R-00-002 (September 2000), at 76.
[30] See TCEQ, Appendix F, Reasonably Available Control Technology Analysis, Dallas-Fort Worth Serious Classification Attainment Demonstration SIP Revision, TCEQ Project Number 2019-078-SIP-NR, available at https://www.tceq.texas.gov/assets/public/implementation/air/sip/dfw/dfw_ad_sip_2019/DFWAD_19078SIP_Appendix_F_pro.pdf (URL dated October 12, 2021).
[31] Delegation Documents for State of Texas, see https://www.epa.gov/tx/region-6-delegation-documents-state-texas-0.

- Holcim U.S., Inc. (formerly Holnam) currently has two dry preheater/precalciner (PH/PC) kilns equipped with SNCR. On January 14, 2009, EPA approved the current source cap of 5.3 tons per day (tpd) NOx for Holcim at 30 TAC §117.3123 as satisfying RACT for 1997 8-hours ozone NAAQS.[32]

- Texas Industries, Inc. (TXI) currently operates one dry (PH/PC) kiln #5. The permitted capacity of this kiln is 2,800,000 tons of clinker per year, and it has a permitted emissions factor of 1.95 lb NOx/ton of clinker. Based on these permit limits, this kiln is therefore limited to a maximum of 7.48 tpd NOx, compared to the current 30 TAC §117.3123 source cap of 7.9 tpd NOx. Kiln #5 typically operates well below the source cap, at an average emission factor below 1.5 lb NOx/ton of clinker. EPA approved this limit as RACT on February 22, 2019 (84 FR 5601). The current NOx Source Cap (tpd) for Ellis County cement plants is shown below.

**Table 3.D: NOX Source Cap for Ellis County Cement Plant**

| **Cement Plant** | **NOx Cap - tpd** |
|---|---|
| Ash Grove | 4.4 |
| Holcim | 5.3 |
| TXI | 7.9 |
| Total | 17.6 |

**Emission Limits and Compliance Requirements in the Final Rule**

In setting the emission limits for long wet kilns, EPA considered a range of emission limits from 3.88 to 6.0 lb/ton of clinker produced. EPA reviewed a 2008 ozone NAAQS RACT standard of 3.88 limit. *See* 25 Pa. Code 129.97 (h)(1). In particular, EPA notes that it has approved a Texas rule establishing an emissions limit of 4.0 lb/ton of clinker. *See* 74 FR 1927 (January 14, 2009) (approving Texas Administrative Code (TAC), title 30, chapter 117, section 117.3110(a)(1)(B), among other provisions). The final rule establishes an emissions limit of 4.0 lb/ton clinker for long wet kilns (as we had proposed).

For setting emission limits for long dry kilns, EPA reviewed the consent agreement and final order (CAFO) for Docket No. CAA-01-2013-0053 issued to Dragon Products Company, in Maine; LaFarge Building Materials – Ravena Cement Plant of New York [subject to NSPS, 40 CFR 60.62(a)]; Hercules Cement Company LP/Stockertown in Pennsylvania [subject to 25 Pa Code §129.97(h)(2), 2008 Ozone RACT]; and Holcim US, Inc – Joppa Plan in Illinois [subject to 35 IAC 217.224(a), 2008 Ozone RACT]. These plants are assigned NOx emissions limit of 2.33, 1.5, 3.44, and 5.1 lbs/ton of clinker, respectively, averaging an emissions limit of 3.1. EPA also reviewed a $NO_X$ emission limit of 5.1 lbs/ton of clinker (69 FR 15681; March 26, 2004). We also reviewed the EPA-approved Texas SIP limit at 30 TAC 117.3110(a)(2), which is 5.1 lbs/ton of clinker. We note that the LaFarge cement plant in New York, is required to comply with a limit of 1.5 lbs/ton of clinker. For the Joppa Illinois plant, air permit 9509119 – at section 8.2 subpart H identifies a limit of 5.1 lbs/ton of clinker for kiln #2. Kiln #2 (J-47) is not equipped with post-combustion controls such as SNCR. Several data in our review showed 5.1 lbs/ton of clinker to

[32] January 14, 2009 (74 FR 1927).

be a typical limit when a source operates without SNCR. Taking the largest emission limit of 5.1 lbs/ton of clinker from the above list and applying a conservative control efficiency of 41% reduction through use of SNCR as control device ((5.1-3.0)/(5.1) x 100 = 41) would result in an emission limit of 3.0 lb/ton. The final rule establishes an emissions limit of 3.0 lb/ton clinker for long dry kilns (as we had proposed).

For setting emission limits for pre-calciner kilns, EPA reviewed a 2008 ozone NAAQS RACT standard, Regulation 19, Rule 13, Section 301.1, Bay Area Air Quality Management District (BAAQMD). This rule establishes a limit of 2.3 lbs/ton of clinker. EPA reviewed BAAQMD Lehigh Southwest Cement Company air permit #A0017. Section III, Table II B - Abatement Devices of said permit sets forth a limit of 2.3 lbs/ton of clinker. EPA also reviewed a consent decree in civil action No. 09-cv-0019-MSK-MEH (D. Colo.) entered with Cemex Construction Materials South LLC – Lyons Cement Plant of Colorado. The CD requires a limit of 1.85 to 3.11 lbs/ton of clinker, with SNCR as the control device. *See also* Colorado Department of Public Health Operating Permit 95OPBO082. Based on the range of emissions limit identified in the agreement above, permit #A0017, and BAAQMD Rule 13, Section 301.1, the final rule establishes an emissions limit of 2.3 lb/ton clinker for pre-calciner kilns (as we had proposed).

For setting emission limits for preheaters, EPA based the emission limit of 3.8 lb/ton on EPA-approved Texas and Illinois standards. *See, e.g.*, Appendix F, Reasonably Available Control Technology Analysis, https://www.tceq.texas.gov/assets/public/implementation/air/sip/dfw/dfw_ad_sip_2019/DFWAD_19078SIP_Appendix_F_pro.pdf (URL dated October 12, 2021); Illinois 35 IAC 217.224(a). Also *see* Table III at (69 FR 15681, March 26, 2004). The final rule establishes an emissions limit of 3.8 lb/ton clinker for preheater kilns (as we had proposed).

For setting emission limits for preheater/precalciner kilns, EPA reviewed a 2008 ozone NAAQS RACT standard, Pennsylvania Rule 25 Pa Code §129.97(h)(3). This rule establishes a limit of 2.36 lbs/ton of clinker. EPA reviewed Illinois Rule 35 IAC 217.224(a). This rule establishes a limit of 2.8 lbs/ton of clinker. EPA also reviewed California Rule 1161(C)(2).This rule establishes a limit of 2.8 lbs/ton of clinker. See MDAQMD Federal Operating Permit # 100005 permits for CEMEX Construction Materials Pacific - Victorville and Apple Valley, Permit Number: 11800001 MDAQMD Federal Operating Permit Mitsubishi Cement Corporation. EPA also reviewed January 14, 2009 (74 FR 1927), Docket ID No. EPA-R06-OAR-2007-1147; and January 14, 2009 (74 FR 1903), Docket ID No. EPA-R06-OAR-2007-0524 establishing a limit of 2.8 lbs/ton of clinker. Both dockets are available at www.regulations.gov. See also 30 TAC 117.3110(a)(4). Based on above information, the final rule establishes an emissions limit of 2.8 lb/ton clinker for preheater kilns (as we had proposed).

Generally, the emission limits in the final rule can be met through installation and operation of SNCR on all types of cement kilns covered by the final rule.

**Performance Tests and Monitoring**

In the final rule, EPA is requiring that performance tests be conducted on annual basis and in accordance with the applicable reference test methods in 40 CFR part 60, any alternative test method approved by EPA as of the effective date of the final rule, or other methods and procedures approved by EPA through notice-and-comment rulemaking.

EPA solicited comment on whether it was feasible or appropriate to require affected units (kilns) to be equipped with continuous emission monitoring systems (CEMS) to measure and monitor the NOx concentration (emissions level) instead of conducting performance tests on a semiannual basis (as we had proposed).

In response to comments received, EPA has established provisions in the final rule allowing affected units in this industry that operate NOx CEMS meeting specified requirements to use CEMS data in lieu of performance tests and parametric monitoring to demonstrate compliance. For affected units that do not operate a NOx CEMS, the final rule requires owners and operators to conduct an initial performance test before the 2026 ozone season to establish appropriate ranges for operating parameters and to subsequently conduct annual $NO_X$ performance tests. The final rule also requires owners and operators to monitor and record kiln stack exhaust gas flow rate, hourly clinker production rate or kiln feed rate, and stack exhaust temperature during the initial performance test and subsequent annual performance tests, and to continuously monitor and record those parameters to demonstrate continuous compliance with the NOx emissions limits. To avoid challenges in scheduling and availability of testing firms, the annual performance tests do not have to be conducted during the ozone season.

Owners and operators of affected units must also reassess and adjust the site-specific operating parameters in accordance with the results of each performance test, and report and include ongoing site-specific operating parameter data in the annual reports to EPA and the semi-annual title V monitoring reports to the relevant air permitting authority.

# 4 Iron and Steel Mills and Ferroalloy Manufacturing+

**Background**

The steel and iron making processes are iterative processes during which iron is first produced and then further refined to steel. The most common furnace types used for iron and steel production are blast furnaces, basic oxygen process furnaces (BOF), electric arc furnaces (EAF), annealing furnaces, ladle metallurgy furnaces (LMF), and reheat furnaces.

NOx emissions from iron and steel production are most often thermal NOx from the combustion of fossil fuels and other raw materials in furnaces or ancillary processes. The mixture of air and fuel in the furnace react to form NOx. Fuel and prompt NOx are also generated through oxidation of nitrogen compounds within the fossil fuels and the oxidation of hydrogen cyanide (HCN), respectively.

Detailed information describing iron and steel production was included in the TSD supporting the proposal.[33] This information included details related to the iron making process, the steel production process, and the ferroalloy manufacturing process; federal and state regulations that apply to facilities with these processes; and available NOx control technologies. This can be found in Section 4 of the TSD to the proposal and is not repeated here.

**Emissions Limits and Compliance Requirements in the Final Rule**

*Summary of Proposed Requirements*

EPA proposed to establish emissions control requirements for the Iron and Steel Mills and Ferroalloy Manufacturing source category for emission units that directly emit or have the potential to emit 100 tpy or more of NOx and for facilities containing two or more such units that collectively emit or have the potential to emit 100 tpy or more of NOx. EPA proposed NOx emissions standards based on relevant available information for the source category, applicable federal and state rules, and active air permits or enforceable orders issued to affected facilities in the iron and steel and ferroalloy manufacturing industry. A summary of the proposed standards was provided in Table VII.C-3 of the preamble to the proposed rule (87 FR 20145).

Based on the use of low-NOx emissions technology such as SCR, SNCR, flue gas recirculation (FGR), newer generation LNB, or optimization of existing LNB, EPA proposed NOx emissions limits for the following types of units for affected facilities in the iron and steel and ferroalloy manufacturing industry:

- Blast furnaces,
- Basic oxygen furnaces,
- Electric arc furnaces,
- Ladle/tundish preheaters,
- Reheat furnaces,
- Annealing furnaces,
- Vacuum degassers,
- Ladle metallurgy furnaces,
- Taconite production kilns,
- Coke ovens (charging and pushing), and
- Boilers (coal, residual oil, distillate oil, and natural gas).
-

*Summary of Final Rule Requirements*

EPA received comments from a number of different stakeholders, including trade organizations, industry, and state environmental agencies, who argued that EPA had not provided sufficient information to demonstrate the feasibility of controls on which the proposed $NO_X$ emissions limits were based. In response to these comments, EPA conducted additional evaluations, including a re-evaluation of the emissions controls that are feasible for all types of furnaces. The data we have reviewed is insufficient at this time to support a generalized

[33] See Document ID Number EPA-HQ-OAR-2021-0668-0145.

conclusion that the application of NOx controls, including SCR or other NOx control technologies such as LNB, is currently both technically feasible and cost effective on a fleetwide basis for these emission source types in this industry. Based on these additional evaluations, EPA has decided not to finalize the proposed emission limits for blast furnaces, BOFs, ladle and tundish preheaters, annealing furnaces, vacuum degassers, taconite kilns, coke ovens, and electric arc furnaces (EAFs) at this time.

EPA is finalizing emissions control requirements for reheat furnaces that directly emit or have the potential to emit 100 tpy or more of NOx. EPA is also finalizing a revised definition for reheat furnaces to include all furnaces used to heat steel product, including metal ingots, billets, slabs, beams, blooms and other similar products, to temperatures at which it will be suitable for deformation and further processing. There are several types of reheat furnaces, including those that operate with a continuous feed of material and those that operate with batches of feed material. Of the continuous feed type, reheat furnaces can be further classified as pusher, rotary hearth, walking beam, walking hearth, or roller hearth type. Information reviewed post-proposal indicates that LNB are feasible for all types of reheat furnaces. Through review of facility operating permits, EPA found that LNB is required for reheat furnaces producing a variety of steel products including bar, rolled coil, and plate steel. Therefore, for Iron and Steel and Ferroalloy manufacturing, EPA is finalizing requirements for reheat furnaces that will require the use of low-$NO_X$ burners (LNB) or equivalent low-$NO_X$ technology that achieves at least a 40% reduction from baseline $NO_X$ emissions. We provide additional discussion below under the heading *Controls on Reheat Furnaces*.

*Controls on Blast furnaces, BOFs, ladle and tundish preheaters, annealing furnaces, vacuum degassers, taconite kilns, coke ovens, or EAFs.*

Many comments on the proposed rule stated that EPA did not sufficiently demonstrate that the proposed standards were technologically feasible for iron and steel emission units of these types and that the record is insufficient and does not support establishing NOx emission control requirements. Several commenters urged EPA not to finalize emissions standards for iron and steel emissions units such as blast furnaces, BOFs, ladle and tundish preheaters, annealing furnaces, vacuum degassers, taconite kilns, coke ovens, and EAFs. Commenters explained that the NOx standards as proposed should not be included in the final rule for several reasons, including complications related to the uniqueness of each emissions unit, various design-related challenges, and expected impracticality of implementation of add-on NOx control technology. Furthermore, commenters stated that SCR had not been applied for reasonably available control technology (RACT), best available control technology (BACT), or lowest available emissions rate (LAER) purposes on iron and steel units.

In the preamble to the proposed rule, EPA indicated that it assumed that these source types (excluding taconite kilns) could meet the proposed emission limits through the application of SCR and/or SNCR. Commenters expressed concern about requirements to install SCR control on the units for which EPA proposed emissions limits. According to several commenters, EPA did not conduct a complete technical evaluation to determine that SCR is feasible. The commenters stated that iron and steel units had not installed SCR except in a few rare instances for experimental reasons and that SCR technology was not readily available or known for the iron and steel industry. One industry commenter in particular (United States Steel Corporation (U.S. Steel))[34] noted that SCR is not feasible for the emissions units EPA proposed to regulate. To elaborate on that point, the commenter (U.S. Steel) indicated that installing SCR control on some of the emission units at U.S. Steel's integrated iron and steel facilities would require significant preconditioning and heating of the exhaust gas to make it amenable to SCR. According to the commenter, this process would be difficult to design and operate, and would also require increased use of natural gas, which would result in other impacts and costs not considered by EPA.

Similarly, comments received from the Mississippi Department of Environmental Quality (MDEQ) on the proposed requirements expressed that EPA should not assume NOx control is achievable for all units in the source category. The commenter stated that EPA did not fully evaluate the applicability of NOx control across all sources and only evaluated a handful of Iron and Steel Mills and Ferroalloy Manufacturing emission units. Comments from MDEQ critiqued EPA's use of a limited number of facilities and units modeled for the proposed rule, and the proposed extension of the calculated limits to all units in the source category. In terms of SCR feasibility specifically, MDEQ stated that "[s]ome of the furnaces and heaters are not even equipped with adequate stacks to support add-on controls and stack gas would have to be reheated to route it through an SCR." These comments were echoed by the West Virginia Department of Environmental Protection (WV DEP)[35] who stated that the proposal lacks technical basis.

Comments from owners of two ferroalloy manufacturing plants (Felman Production (Felman) and CC Metals and Alloys (CCMA)) who use EAFs in their production processes stated that EPA had not assessed the viability of controls of EAFs in this industry. Felman and CCMA noted a number of unique concerns regarding the applicability of controls to EAFs in ferroalloy production. The commenters also claim that EPA had not provided evidence in the record supporting controls on any EAFs.[36]

Nucor Corporation (Nucor)[37] also stated that the proposed NOx limits are not technically or economically feasible. Consistent with remarks from other commenters, Nucor stated that EPA had not provided an adequate basis in the record to support the proposed emissions limits for EAFs.

In response to the comments EPA received concerning NOx controls for iron and steel emission units, EPA reviewed multiple permits to determine which, if any NOx controls are being used in the industry. EPA reviewed more than 50 permits across multiple states with varying iron and steel emissions source types. EPA also searched EPA's RACT/BACT/LAER Clearinghouse (RBLC)[38] for additional information on NOx limits and control technologies that may have been applied to sources in this industry as a result of a RACT, BACT, or LAER

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[34] See Document ID Number EPA-HQ-OAR-2021-0668-0798.
[35] See Document ID Number EPA-HQ-OAR-2021-0668-0359.
[36] See for example Document ID Number EPA-HQ-OAR-2021-0668-0345, page 6.
[37] See Document ID Number EPA-HQ-OAR-2021-0668-0280.
[38] EPA, Clean Air Technology Center, RACT/BACT/LAER Clearinghouse (RBLC), https://www.epa.gov/catc/ractbactlaer-clearinghouse-rblc-basic-information.

analysis. These reviews identified three annealing furnaces, two galvanizing furnaces, and one reheat furnace, with combustion or post-combustion controls. These are discussed further in the sections below.

*Review of Post-Combustion Controls on Emission Sources Other Than Reheat Furnaces*

**Annealing Furnaces**. Annealing is a heat treatment process used to change the hardness and strength of steel. As shown in Table 4-1, very few of these were found in the RBLC to be employing post-combustion controls. For the U.S. Steel facility, the annealing furnace is part of a continuous galvanizing line where the steel is annealed prior to galvanization (coating with zinc). The PRO TEC facility is part of USS Galvanizing, Inc., and so it is also likely part of a galvanizing process. It is not clear whether annealing furnaces associated with galvanizing processes are inherently different than annealing furnaces serving other types of steel finishing processes (which offer exhaust streams conducive to SCR application). However, based on other processes present in the RBLC, the Mount Vernon facility does not appear to conduct galvanizing, and it has SCR installed.

**Table 4.A: Annealing Furnace Post-Combustion NOx Controls**

| Process | Capacity (MMBtu/hr) | Control(s) | NOx Limit | State | Facility |
|---|---|---|---|---|---|
| Annealing | N/A | SCR | 6.6 lb/hr | MI | US Steel Great Lakes Works |
| Annealing | 120 | ULNB, SCR | 0.06 lb/MMBtu | AL | MOUNT VERNON MILL |
| Annealing | 77 | SCR | 0.06 lb/MMBtu | OH | PRO TEC COATING COMPANY |

Source: EPA RBLC.

**Other Sources.** Another source type identified with post-combustion NOx controls applied are galvanizing line furnaces. These furnaces are used to heat the molten bath of zinc into which the steel part is dipped for galvanization. These sources are listed in Table 4.B. Information for the Nucor Steel facility comes from the permit documentation above, while the other example for Big River Steel comes from the RBLC (in this case, the actual process is inferred from all of the processes listed for the facility).

**Table 4.B: Post-Combustion NOx Controls on Other Iron and Steel Source Types**

| Process | Capacity (MMBtu/hr) | Control(s) | NOx Limit (lb/MMBtu) | State | Facility |
|---|---|---|---|---|---|
| Furnace, Galvanizing Line | 128 | SCR/SNCR | 0.0075 | AR | NUCOR STEEL ARKANSAS |
| Furnace, Galvanizing Line | 151 | SCR | 0.035 | AR | BIG RIVER STEEL LLC |

After review and consideration of public comments on the proposal and the review of iron and steel and ferroalloy manufacturing operating permits and the RBLC, EPA recognizes and agrees with concerns associated with whether the feasibility and cost-effectiveness of installation and operation of NOx controls at iron and steel mills and ferroalloy manufacturing facilities has been adequately demonstrated in the present record on a fleetwide basis across the covered states and is not finalizing the ten proposed emissions limits that would necessitate the use of SCR at certain facilities.

Based on the above, EPA is not finalizing the proposed emissions limits for blast furnaces, BOFs, ladle and tundish preheaters, annealing furnaces, vacuum degassers, taconite kilns, coke ovens, or EAFs.

EPA is aware of many examples of low-NOx technology utilized at furnaces, kilns, and other emissions units in other sectors with similar stoichiometry, including taconite kilns, blast furnace stoves, electric arc furnaces (oxy-fuel burners), and many other examples at refineries and other large industrial facilities. EPA anticipates that with adequate time, modeling, and optimization efforts, such NOx reduction technology may become achievable and cost-effective for these particular types of emissions units. However, EPA is not finalizing regulatory requirements for these emissions units at this time. Reheat furnaces and boilers (discussed in Section 6 of this document) are the only type of emissions unit within the Iron and Steel Mills and Ferroalloy Manufacturing industry that this final rule applies to and are discussed in more detail in the section below.

*Controls on Reheat Furnaces*

EPA has determined that combustion controls are technically feasible and cost-effective for reheat furnaces in the iron and steel industry. Reheat furnaces are used at both integrated iron and steel facilities as well as steel mini-mills (*i.e.*, EAF mills). They are used to reheat semi-finished steel in the form of ingots, billets or slabs, so that the steel can be further processed (*e.g.,* rolled) into finished products.

EPA performed a review of state permits and EPA's RBLC[39] to identify controls that are currently in place for reheat furnaces. This review identified 32 reheat furnaces that have an associated combustion control to reduce NOx emissions. The controlled furnaces range in size from 38 to 720 MMBtu/hr. Most of these units are controlled using LNB. However, five units are controlled with ultra-low NOx burners (ULNB), three use LNB plus FGR, and one furnace was found with LNB and SCR controls. (See the discussion below on the issues encountered by the latter furnace with SCR.)

Based on the current set of identified reheat furnaces with combustion controls, this final rule requires installation of these controls or equivalent low-$NO_X$ technology on a range of reheat furnace types. Table 4-3 summarizes the types of controlled reheat furnaces identified, the range of corresponding NOx emission limits, furnace capacity, and controls applied. Note that not all reheat furnaces were identified by type in the permits or the RBLC, and these are listed simply as reheat furnaces in Table 4-3. Also, some emission limits were not specified in units of lb/MMBtu, so these are listed as N/A (not available).

[39] EPA, Clean Air Technology Center, RACT/BACT/LAER Clearinghouse (RBLC), https://www.epa.gov/catc/ractbactlaer-clearinghouse-rblc-basic-information.

**Table 4.C: Controlled Reheat Furnaces**

| Furnace Type | Count | NOx Limit (lb/MMBtu) | Capacity (MMBtu/hr) | Controls Applied |
|---|---|---|---|---|
| bar mill | 1 | 0.13 | 228 | LNB |
| Billet | 7 | 0.073-0.10 | 77-350 | LNB, LNB+FGR, ULNB |
| hot strip mill | 3 | 0.35 | 630 | LNB |
| reheat furnace | 10 | 0.070-0.17 | 38-450 | LNB, LNB+FGR, ULNB |
| Rotary | 1 | N/A | N/A | LNB |
| Slab | 3 | 0.077-0.10 | 265-500 | LNB, LNB+SCR |
| tunnel | 2 | 0.1 | 103-150 | LNB |
| walking beam | 5 | 0.07-0.35 | 261-720 | LNB, ULNB |

Source: State permits and EPA RBLC.

The furnace identified with SCR was the only reheat furnace that EPA found to have post-combustion controls. This reheat furnace is at an NLMK facility in Indiana (formerly Beta Steel). Some additional information regarding the NOx controls at this furnace was obtained from the Indiana Department of Environmental Management (IDEM).[40] This included a BACT determination from 2003 which indicated that the reheat furnace was initially installed in the early 1990's with LNB and SCR. The original NOx emissions limit was set to 0.014 lb/MMBtu; however, testing in the late-1990's indicated that the facility could not meet that limit. The facility requested that the limit be raised to be closer to other RBLC entries, which as indicated in Table 4-3, were being met with LNB/ULNB in many cases. In their request, NLMK indicated that the exhaust conditions were too variable for optimal SCR operation. In particular, temperature and particulate matter concentrations vary depending on the material being heated. The IDEM relaxed the emissions requirement (0.077 lb/MMBtu) for the unit based on the highest emission rate of three previous stack tests.

As stated above, EPA has determined that combustion controls are feasible and cost-effective for reheat furnaces. This determination is supported by the information in the preceding section regarding the range of reheat furnace types and sizes that have successfully applied combustion controls. EPA is finalizing a test-and-set requirement for reheat furnaces that requires the installation of LNB or equivalent low-$NO_X$ technology on units emitting more than 100 tons of NOx per year to reduce NOx emissions by 40% from baseline levels.

**Compliance Requirements in the Final Rule**

*Performance Tests and Monitoring*

EPA proposed to require each owner or operator of an affected unit subject to the NOx emissions limit for Iron and Steel Mills and Ferroalloy Manufacturing emissions units to install, calibrate, maintain, and operate a CEMS for the measurement of NOx emissions. EPA proposed that each emissions unit had to conduct an initial performance test and to operate CEMS to assure compliance.

[40] S. Roe, SC&A, personal communication with B. Farrar, IDEM, 1/10/2023.

Commenters stated concerns with the proposed CEMS requirements for a variety of reasons. One key concern expressed by commenters was the cost of installing, operating, and maintaining the CEMS unit, in particular for smaller units with lower emissions. Echoing similar comments related to the CEMS requirement, one commenter (Felman and CCMA) who produces ferroalloys asked that EPA not finalize this monitoring requirement for ferroalloy operations. The commenter stated that "[t]he complex ductwork, high flowrates and temperatures, and significant levels of dust associated with ferroalloy manufacturing makes CEMS technically complex and more likely to operate unreliably."[41] This commenter stated that in EPA's final rulemaking for the Ferroalloy NESHAP RTR, EPA decided to amend the baghouse monitoring requirements to allow visible emissions monitoring instead.[42]

One commenter (Nucor)[43] claimed EPA had not provided a basis for requiring CEMS and that it is a burdensome monitoring requirement that is technically and economically infeasible. The commenter stated that for most ladle and tundish preheaters, bell annealing furnaces, and mobile reheat furnaces, which do not have existing ductwork, there is no practical way to install CEMS. According to Nucor, there are other simpler compliance assurance measures that are less onerous and sufficient to ensure ongoing compliance.

Other commenters described complexities in using a CEMS to monitor NOx emissions on mobile reheat surfaces, stated that the unique configuration of certain facilities would render it impossible for a CEMS to differentiate emissions from a reheat furnace and other units, like waste heat boilers, and recommended that in place of CEMS, EPA could allow for CEMS or performance testing and recordkeeping.

Of the reheat furnace permits reviewed, one facility was found to be required to monitor NOx emissions via a CEMS. Compliance for most of the other controlled reheat furnaces was typically specified as periodic testing or simply through monitoring and reporting of fuel usage to ensure that the maximum allowed fuel usage is not exceeded.

The final rule for iron and steel reheat furnaces allows compliance to be demonstrated through CEMS or via annual performance tests and continuous parametric monitoring to determine compliance with the 30-day rolling average emissions limit during the ozone season. Affected units subject to this rule that operate NOx CEMS meeting specified requirements may use CEMS data in lieu of performance tests and continuous parametric monitoring to demonstrate compliance. For affected units that do not use CEMS, the final rule requires the owner or operator to monitor and record stack exhaust gas flow rate, hourly production rate, and stack exhaust temperature during the initial performance test and subsequent annual performance tests to assure compliance with the applicable emissions limit. The owner or operator must then continuously monitor and record those parameters to demonstrate continuous compliance with the NOx emissions limits. To avoid challenges in scheduling and availability of testing firms, the annual performance test does not have to be performed during ozone season. Owners and operators of affected units must also reassess and adjust the site-specific operating parameters in accordance with the results of each performance test, and report and include ongoing site-specific

[41] See Document ID Number EPA-HQ-OAR-2021-0668-0345, page 6.
[42] See 82 FR 5403.
[43] See Document ID Number EPA-HQ-OAR-2021-0668-0280.

operating parameter data in the annual reports to EPA and the semi-annual title V monitoring reports to the relevant air permitting authority.

# 5 Glass and Glass Product Manufacturing

**Process Description[44]**

Glass melting furnaces are used by the glass industry in the production of glass. The glass melting furnaces contribute to most of the total emissions from the glass plant. Essentially all of the Oxides of Nitrogen (NOx) emissions associated with glass manufacturing are generated in the melting furnaces due to the high process temperatures. Nitrogen oxides form when nitrogen and oxygen react in the high temperatures of the furnace.

Detailed information describing glass production can be found in Section 5 of the TSD to the proposal and is not repeated here.

**Federal Rules affecting Glass Plants**

Glass plants are subject to the Glass Manufacturing NESHAP (40 CFR Part 63, subpart SSSSSS) and NSPS (40 CFR part 60, subpart CC). Glass manufacturing facilities that are designated as an area source of hazardous air pollutants (HAP) emissions are subject to the Glass Manufacturing Area Source NESHAP (40 CFR part 63, subpart SSSSSS).

The NSPS implementing CAA section 111(b) for Glass Manufacturing Plants was first promulgated at 40 CFR part 60, subpart CC on October 7, 1980 (45 FR 66751). EPA conducted three additional reviews of these standards on October 19, 1984 (49 FR 41030), February 14, 1989 (54 FR 6674), and October 17, 2000 (65 FR 61759). The NSPS applicable to the glass manufacturing industry only provides standards for particulate matter from sources and does not provide standards or averaging times for NOx.

**NOx Controls**

The NACAA (formerly STAPPA/ALAPCO) has recommended requiring “combustion modifications, process changes and post-combustion controls [Selective Non-Catalytic Reduction] (SNCR)” to limit NOx emissions from the glass furnaces source category.[45] SNCR is a post combustion control technology used to reduce NOx emissions without the presence of a catalyst. The NACAA has also noted that “RACT limits of 5.3-5.5 lbs NOx/ton of glass removed have been adopted, as well as limits as low as 4.0 lbs NOx/ton of glass removed” and recommended “[requiring] sources to coordinate installation of controls with routine furnace rebuilds to lower costs.”[46]

The European Union Commission charged with establishing the BAT to control NOx emissions from the production of glass outlines the control techniques shown below in Table 5.A below.

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[44] See generally EPA, AP-42 Compilation of Air Emissions Factors, Mineral Products Industry, Chapter 11, Mineral Products Industry, Section 11.15, Glass Manufacturing, Final Section (October 1986, reformatted January 1995).
45 STAPPA/ALAPCO, Controlling Nitrogen Oxides Under the Clean Air Act: A Menu of Options, 78-79 (July 1994), available at https://p2infohouse.org/ref/02/01245/3017101.pdf.
[46] Id.

**Table 5.A: European Union Commission $NO_X$ BAT Controls.**

| **Primary Techniques/Measures** | **Description** |
|---|---|
| Combustion Modifications | |
| (i) Reduction of air/fuel ratio | The technique is mainly based on the following features:<br>- minimization of air leakages into the furnace<br>- careful control of air used for combustion<br>- modified design of the furnace combustion chamber |
| (ii) Reduced combustion air temperature | The use of recuperative furnaces, in place of regenerative furnaces, results in a reduced air preheat temperature and, consequently, a lower flame temperature. However, this is associated with a lower furnace efficiency (lower specific pull), lower fuel efficiency and higher fuel demand, resulting in potentially higher emissions (kg/ton of glass) |
| (iii) Staged combustion | - Air staging – involves sub-stoichiometric firing and the addition of the remaining air or oxygen into the furnace to complete combustion.<br>- Fuel staging – a low impulse primary flame is developed in the port neck (10 % of total energy); a secondary flame covers the root of the primary flame reducing its core temperature |
| (iv) Flue-gas recirculation | Implies the reinjection of waste gas from the furnace into the flame to reduce the oxygen content and therefore the temperature of the flame. The use of special burners is based on internal recirculation of combustion gases which cool the root of the flames and reduce the oxygen content in the hottest part of the flames |
| (v) Low-NOx burners | The technique is based on the principles of reducing peak flame temperatures, delaying but completing the combustion and increasing the heat transfer (increased emissivity of the flame). It may be associated with a modified design of the furnace combustion chamber |
| (vi) Fuel choice | In general, oil-fired furnaces show lower NOx emissions than gas-fired furnaces due to better thermal emissivity and lower flame temperatures |
| Special furnace design | Recuperative type furnace that integrates various features, allowing for lower flame temperatures. The main features are:<br>- specific type of burners (number and positioning)<br>- modified geometry of the furnace (height and size)<br>- two-stage raw material preheating with waste gases passing over the raw materials entering the furnace and an external cullet preheater downstream of the recuperator used for preheating the combustion air |

| | |
|---|---|
| Electric melting | The technique consists of a melting furnace where the energy is provided by resistive heating. The main features are:<br>- electrodes are generally inserted at the bottom of the furnace (cold-top)<br>- nitrates are often required in the batch composition of cold-top electric furnaces to provide the necessary oxidizing conditions for a stable, safe and efficient manufacturing process |
| Oxy-fuel melting | The technique involves the replacement of the combustion air with oxygen (>90% purity), with consequent elimination/reduction of thermal NOx formation from nitrogen entering the furnace. The residual nitrogen content in the furnace depends on the purity of the oxygen supplied, on the quality of the fuel (% N2 in natural gas) and on the potential air inlet |
| Chemical reduction by fuel | The technique is based on the injection of fossil fuel to the waste gas with chemical reduction of NOx to N2 through a series of reactions. In the 3R process (which is proprietary), the fuel (natural gas or oil) is injected at the regenerator entrance. The technology is designed for use in regenerative furnaces. |
| Selective catalytic reduction (SCR) | The technique is based on the reduction of NOx to nitrogen in a catalytic bed by reaction with ammonia (in general aqueous solution) at an optimum operating temperature of around 300 – 450 °C. One or two layers of catalyst may be applied. A higher NOX reduction is achieved with the use of higher amounts of catalyst (two layers) |
| Selective non-catalytic reduction (SNCR) | The technique is based on the reduction of NOx to nitrogen by reaction with ammonia or urea at a high temperature. The operating temperature window must be maintained between 900 and 1,050 °C |
| Minimizing the use of nitrates in the batch formulation | The minimization of nitrates is used to reduce NOx emissions deriving from the decomposition of these raw materials when applied as an oxidizing agent for very high quality products where a very colourless (clear) glass is required or for other glasses to provide the required characteristics. The following options may be applied:<br>- Reduce the presence of nitrates in the batch formulation to the minimum commensurate with the product and melting requirements.<br>- Substitute nitrates with alternative materials. Effective alternatives are sulphates, arsenic oxides, cerium oxide.<br>- Apply process modifications (e.g. special oxidizing combustion conditions) |

Reproduced from Official Journal of European Union Commission, Best Available Techniques (BAT) Conclusions Under Directive 2010/75/EU of the European Parliament and of the Council on Industrial Emissions for the Manufacture of Glass, February 28, 2012, Table 1.10.2.

EPA's Menu of Control Measures (MCM) provides state, local and tribal air agencies with information on existing criteria pollutant emission reduction measures as well as relevant information concerning the efficiency and cost effectiveness of the measures. State, local, and tribal agencies may use this information in developing emission reduction strategies, plans and programs to assure they attain and maintain the NAAQS. The information from the MCM can also be found in the Control Measures Database (CMDB), a major input to the Control Strategy Tool (CoST), which EPA used in the NOx control strategy analysis included in the Non-EGU Screening Assessment memorandum.[47] Information about control measures to reduce NOx emissions from glass manufacturing operations is shown in Table 5.B below.

[47] EPA, Control Measures Database (CMDB) for Stationary Sources, available at https://www.epa.gov/system/files/other-files/2021-09/cmdb_2021-09-02_0.zip (URL dated January 6, 2022).

**Table 5.B: List of NOx Controls Available for Glass Manufacturing Furnaces**

| **Source Category** | **Emission Reduction Measure** | **Control Efficiency (%)** | **Description/Notes/Caveats** | **References** |
|---|---|---|---|---|
| Glass Manufacturing - Container | Cullet Preheat | 25 | This control is the use of cullet preheat technologies to reduce NOx emissions from glass manufacturing operations. This control is applicable to container glass manufacturing operations. | EPA 2006b, EPA 1998e, EPA 1994f |
| Glass Manufacturing - Container | Electric Boost | 10 | This control is the use of electric boost technologies to reduce NOx emissions from glass manufacturing operations. This control applies to container glass manufacturing operations. | EPA 2006b, EPA 1998e, EPA 1994f |
| Glass Manufacturing - Container | Selective Catalytic Reduction | 75 | This control is the selective catalytic reduction of NOx through add-on controls. SCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). The SCR utilizes a catalyst to increase the NOx removal efficiency, which allows the process to occur at lower temperatures. This control applies to glass-container manufacturing processes with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994f |
| Glass Manufacturing - Container | Selective Non-Catalytic Reduction | 40 | This control is the reduction of NOx emissions through selective non-catalytic reduction add-on controls. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). This control applies to glass-container manufacturing operations with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994f, EPA 1993c |
| Glass Manufacturing – Container or Flat Glass | Low NOx Burner | 40 | This control is the use of low NOx burner (LNB) technology to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering the temperature of one combustion zone and reducing the amount of oxygen available in another. This control applies to flat glass and container glass manufacturing operations with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, EPA 1998e, EPA 2002a, EPA 1994f |

| | | | | |
|---|---|---|---|---|
| Glass Manufacturing – Flat Glass | Electric Boost | 10 | This control is the use of electric boost technologies to reduce NOx emissions from glass manufacturing operations. This control applies to flat glass manufacturing operations. | EPA 2006b, EPA 1998e, EPA 1994f |
| Glass Manufacturing - Flat Glass | Selective Catalytic Reduction | 75 | This control is the selective catalytic reduction of NOx through add-on controls. SCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). The SCR utilizes a catalyst to increase the NOx removal efficiency, which allows the process to occur at lower temperatures. This control applies to flat-glass manufacturing operations with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994f, EPA 1993c |
| Glass Manufacturing - Flat | Selective Non-Catalytic Reduction | 40 | This control is the reduction of NOx emission through selective non-catalytic reduction add-on controls. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). This control applies to flat-glass manufacturing operations with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994f, EPA 1993c |
| Glass Manufacturing – Pressed | Cullet Preheat | 25 | This control is the use of cullet preheat technologies to reduce NOx emissions from glass manufacturing operations. This control is applicable to pressed glass manufacturing operations. | EPA 2006b, EPA 1998e, EPA 1994f |
| Glass Manufacturing – Pressed | Electric Boost | 10 | This control is the use of electric boost technologies to reduce NOx emissions from glass manufacturing operations. This control applies to pressed glass manufacturing operations. | EPA 2006b, EPA 1998e, EPA 1994f |
| Glass Manufacturing - General | Low NOx Burner | 40 | This control is the use of low NOx burner (LNB) technology to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering the temperature of one combustion zone and reducing the amount of oxygen available in another. This control is applicable to pressed glass manufacturing operations with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, EPA 1998e, EPA 2002a, EPA 1994f |
| Glass Manufacturing - General | OXY-Firing | 85 | This control is the use of Oxy-firing in pressed glass manufacturing furnaces to reduce NOx emissions. Oxygen enrichment refers to the substitution of oxygen for nitrogen in the combustion air used to burn | EPA 2006b |

| | | | | |
|---|---|---|---|---|
| | | | the fuel in a glass furnace. Oxygen enrichment above 90 percent is sometimes called "oxy-firing" | |
| Glass Manufacturing - Pressed | Selective Catalytic Reduction | 75 | This control is the selective catalytic reduction of NOx through add-on controls. SCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). The SCR utilizes a catalyst to increase the NOx removal efficiency, which allows the process to occur at lower temperatures. This control applies to pressed-glass manufacturing operations, and uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994f, EPA 1993c |
| Glass Manufacturing - Pressed | Selective Non-Catalytic Reduction | 40 | This control is the reduction of NOx emissions through selective non-catalytic reduction add-on controls. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). This control applies to pressed-glass manufacturing operations with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994f, EPA 1993c |

Reproduced from EPA, Menu of Control Measures for NAAQS Implementation, available at https://www.epa.gov/air-quality-implementation-plans/menu-control-measures-naaqs-implementation (URL dated January 5, 2022)

In 1994, the Emission Standards Division of the Office of Air Quality Planning and Standards of the U.S. Environmental Protection Agency issued a report detailing alternative control techniques (ACTs) for NOx emissions from glass manufacturing facilities. The table below summarizes the NOx control technologies identified in EPA's ACT document for glass manufacturing.[48]Since 1994, and at least through 2002, the demand for flat, container, and pressed/blown glass continued to increase annually.[49] To meet this demand, the glass manufacturing industry has also continued to grow. The flat glass industry alone was expected in the early 2000s to continue to grow by 10–20% annually due to the increase of flat glass demands within the building construction and car manufacturing industry. Nitrogen oxides are one of the primary air pollutants produced during the production and manufacturing of glass products. However, current federal NSPS and NESHAP regulations only control emissions of particulate matter, metals, and organic hazardous air pollutants. Currently, there is no NSPS that provides standards for NOx from glass manufacturing furnaces. Since 1994, various studies have been conducted by the glass manufacturing industries to help identify preferred techniques for the control of NOx.

**Table 5.C: List of NOx Controls and Reduction Percentages for Glass Furnaces**

| Technology | NOx Reduction (%) |
|---|---|
| Combustion modifications | |
| Low NOx burners | 40 |
| Oxy-firing | 85 |
| Process modifications | |
| Modified furnace | 75 |
| Cullet preheat | 25 |
| Electric boost | 10 |
| Post combustion modifications | |
| SCR | 75 |
| SNCR | 40 |

**State RACT Rules**

While NSPS and NESHAP emission control regulations for glass manufacturing facilities historically focused on particulate and arsenic emissions, state RACT rules have set standards for the control of NOx emissions from glass furnaces. EPA reviewed various RACT NOx rules from states located within the Ozone Transport Region (OTR). EPA chose to review these RACT NOx rules because several OTR states implement Ozone Transport Commission (OTC) model rules and recommendations. EPA also reviewed RACT NOx rules for glass manufacturing in the San Joaquin Valley air quality district in California. During its review, EPA observed that most of the states within the OTR have adopted RACT regulations for the glass manufacturing sector that do not themselves establish the required NOx limits but require a case-by-case evaluation.

[48] EPA, Alternative Control Techniques Document— NOx Emissions from Glass Manufacturing, EPA-453/R-94-037 (June 1994) at 2-7.
[49] U.S. Department of Energy, Glass Industry of the Future – Energy and Environmental Profile of the U.S. Glass Industry, (April 2002), Pages 6 - 9.

EPA focused its review on rules adopted by OTR states that contain RACT NOx limits for glass manufacturing furnaces. EPA reviewed Pennsylvania's RACT rule since it contains RACT NOx limits on a 30-day rolling average for various glass melting furnace types. Pennsylvania's NOx RACT rule requires owners or operators of a glass melting furnace equipped with CEMS to comply with the following emission limits: 4.0 pounds of NOx per ton of glass pulled for container and fiberglass furnaces, 7.0 pounds of NOx per ton of glass pulled for pressed/blown and flat glass furnaces, and 6.0 pounds of NOx per ton of glass pulled from all other glass melting furnaces.[50]

EPA also reviewed New Jersey's RACT rule since it contains a daily averaging period compared to the 30-day averaging period in Pennsylvania's RACT rule. New Jersey's NOx RACT rule requires each owner or operator of a glass manufacturing furnace to comply with the following emission limits: 4.0 pounds of NOx per ton of glass removed for container, pressed/blown, borosilicate, and fiberglass furnaces.[51] Under New Jersey's RACT rule, an owner or operator of a flat glass manufacturing furnace equipped with CEMS shall not emit more than 9.2 pounds of NOx per ton of glass removed each calendar day during the ozone season.[52] New Jersey's RACT rule also incorporates OTC model recommendations.[53]

Maryland's RACT rule requires owners or operators to optimize combustion by performing daily oxygen tests and maintain excess oxygen at 4.5% or less.[54] The San Joaquin Valley air district in California has adopted RACT NOx emission limits that are based on both 30-day rolling and daily averages.[55]

The following table displays the San Joaquin Valley air district's emission limits for container glass, fiberglass, and flat glass melting furnaces.[56] Owners or operators of container glass/fiberglass furnaces applicable to San Joaquin Valley air district's emission limits detailed in the table below were required to be in full compliance with the Tier 3 NOx limits by January 1, 2014. Meanwhile, owners or operators of flat glass furnaces were required to be in full

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[50] Title 25, Part I, Subpart C, Article III, Section 129.304 of PA's NOx RACT regulation provides emission rates for Glass Manufacturing Furnaces. *See https://casetext.com/regulation/pennsylvania-code-rules-and-regulations/title-25-environmental-protection/part-i-department-of-environmental-protection/subpart-c-protection-of-natural-resources/article-iii-air-resources/chapter-129-standards-for-sources/control-of-nox-emissions-from-glass-melting-furnaces/section-129304-emission-requirements*. Owners or operators subject to PA's glass manufacturing furnace RACT NOx regulation shall demonstrate compliance through continuous emissions monitoring systems (CEMS). PA's rule also allows owners or operators to install or operate, or both, an alternative NOx emission monitoring system or method, approved by writing by the Department or appropriate approved local air pollution control agency.

[51] Title 7, Chapter 27, Subchapter 19 of New Jersey's NOx RACT regulation provides NOx emission rates for Glass Manufacturing Furnaces. *See https://www.nj.gov/dep/aqm/currentrules/Sub19.pdf*.

[52] NJAC 7:27-19.15(a) (Procedures and deadlines for demonstrating compliance). For a furnace not equipped with CEMS, compliance must be based upon the average of three one-hour tests, each performed over a consecutive 60-minute period. Id.

[53] Id.

[54] Title 26, Subtitle 11, Chapter 26.11.09 of MD's NOx RACT regulation provides operation standards for Glass Manufacturing Furnaces. *See http://www.dsd.state.md.us/comar/comarhtml/26/26.11.09.08.htm.*

[55] *See* San Joaquin Valley Unified Air Pollution Control District, Rule 4354, "Glass Melting Furnaces" (amended May 19, 2011), available at *https://www.valleyair.org/rules/currntrules/R4354%20051911.pdf*.

[56] *See Id.*

compliance with the Tier 3 NOx limits by January 1, 2011, and the Tier 4 NOx limits by January 1, 2014.

**Figure 5.D: San Joaquin Valley Air District's $NO_X$ Emission Limits for Glass Furnaces**

| Type of Glass Produced | Tier 2 NOx limit | Tier 3 NOx limit | Tier 4 NOx limit |
|---|---|---|---|
| Container Glass | 4.0 [A] | 1.5 [B] | not available |
| Fiberglass | 4.0 [A] | 1.3 [A, C]<br>3.0 [A, D] | not available |
| Flat Glass<br>Standard Option | 9.2 [A]<br>7.0 [B] | 5.5 [A]<br>5.0 [B] | 3.7 [A]<br>3.2 [B] |
| Flat Glass<br>Enhanced Option | 9.2 [A]<br>7.0 [B] | 5.5 [A]<br>5.0 [B] | 3.4 [A]<br>2.9 [B] |
| Flat Glass<br>Early Enhanced Option | 9.2 [A]<br>7.0 [B] | not available | 3.4 [A]<br>2.9 [B] |

[A] Block 24-hour average
[B] Rolling 30-day average
[C] Not subject to California Public Resources Code Section 19511
[D] Subject to California Public Resources Code Section 19511

**Emission Limits and Compliance Requirements in the Final Rule**

Generally, the emission limits in the final rule can be met through installation and operation of low-NOx burners on all glass furnaces covered by the final rule. EPA expects that some units might choose to utilize post-combustion controls as well to meet the emission limits.

In setting the emission limits for the Glass and Glass Product Manufacturing Sector, EPA reviewed RACT NOx rules, air permits, Alternative Control Techniques (ACT), and consent decrees. Based on EPA's review, EPA is finalizing emission limits for this sector that are mostly expressed in terms of mass of pollutant emitted (pounds) per weight of glass removed from the furnace (tons), i.e., pounds of NOx emitted per ton of glass produced (lb/ton). Based on EPA's review, this form of NOx emission limit is effective, practicable, and convenient to record and report to an air agency.

In setting the final NOx emission limit for Container Glass Manufacturing Furnaces, EPA considered a range of emission limits from 1.0 to 5.0 lb/ton of glass produced. In particular, EPA notes that it has approved New Jersey's RACT rule limiting NOx emissions to 4.0 lb/ton of glass removed from the furnace. *See* 83 FR 50506 (October 9, 2018). This emission limit for Container Glass Furnaces in New Jersey's RACT rule is consistent with the NOx limit in Pennsylvania's RACT rule.[57] EPA acknowledges that NOx emissions from some glass manufacturing furnaces

[57] Title 25, Part I, Subpart C, Article III, Section 129.304 of PA's NOx regulation for glass manufacturing furnaces limit NOx emissions to 4.0 pounds of NOx per ton of glass pulled for container glass furnaces. *See https://casetext.com/regulation/pennsylvania-code-rules-and-regulations/title-25-environmental-protection/part-i-department-of-environmental-protection/subpart-c-protection-of-natural-resources/article-iii-air-resources/chapter-129-standards-for-sources/control-of-nox-emissions-from-glass-melting-furnaces/section-129304-emission-requirements*.

are already subject to RACT controls that are more stringent than those that EPA is finalizing in this FIP. During the development of the finalized limits, EPA considered the significant differences that exist in the types, designs, configuration, age, and fuel capabilities among glass furnaces nationwide. EPA finds the final emission limits provide cost-effective emissions reductions while also being responsive to the range of operations and production techniques present currently within the industry.

For Pressed/Blown and Fiberglass Manufacturing Furnaces, EPA considered a range of emission limits from 1.0 – 7.0 lb/ton of glass produced. EPA based the final emission limit of 4.0 lb/ton on EPA-approved New Jersey and Pennsylvania RACT rules for glass melting furnaces. EPA also observed that the 4.0 lb/ton limit was consistent for these types of glass manufacturing furnaces with states located in the OTR. *See* 76 FR 52283 (August 22, 2011).

For Flat Glass Manufacturing Furnaces, EPA considered a range of 5.0 – 9.2 lb/ton of glass produced. EPA is finalizing an emissions limit of 7.0 lb/ton on a 30-day rolling average basis, consistent with the NOx limits in Pennsylvania's RACT rule. EPA had proposed a NOx emissions limit of 9.2 lb/ton on a 30-day rolling average basis but is establishing the final emissions limit at 7.0 lb/ton because that is the emissions limit in the Pennsylvania rule that corresponds to a 30-day averaging period; the 9.2 lb/ton limit in the New Jersey rule corresponds to a daily averaging period. The 7.0 lb/ton limit is generally achievable with low NOx burner combustion controls.

In determining the averaging time for the limits, EPA focused its review on the various RACT NOx rules from states located in the OTR. The OTR states have adopted emission limits with varying averaging times. Based on EPA's review, the OTR states varied between a 30-day rolling average or a daily average.[58] EPA also reviewed RACT NOx regulations for the glass manufacturing sector outside the OTR and observed that 30-day rolling averages and daily averages varied throughout the states.[59] EPA is finalizing a requirement that owners and operators of glass manufacturing furnaces must comply with the final NOx emissions limits on a 30-day rolling average time frame. EPA believes that this averaging timeframe is consistent with

[58] Pennsylvania's RACT NOx emission limits are based on 30-day rolling average. *See* Title 25, Part I, Subpart C, Article III, Section 129.304, *see https://casetext.com/regulation/pennsylvania-code-rules-and-regulations/title-25-environmental-protection/part-i-department-of-environmental-protection/subpart-c-protection-of-natural-resources/article-iii-air-resources/chapter-129-standards-for-sources/control-of-nox-emissions-from-glass-melting-furnaces/section-129304-emission-requirements.* New Jersey's and Massachusetts' rules contain more stringent daily averages. Title 7, Chapter 27, Subchapter 19 of New Jersey's NOx RACT regulation provides NOx emission rates for Glass Manufacturing Furnaces. *See https://www.nj.gov/dep/aqm/currentrules/Sub19.pdf*. 310 CMR Section 7:19 of Massachusetts regulations provides RACT NOx emission limits for Glass Manufacturing Furnaces. *See https://www.mass.gov/doc/310-cmr-700-air-pollution-control-regulations/download*. Title 26, Subtitle 11, Chapter 26.11.09 of Maryland's NOx RACT regulation provides operation standards for Glass Manufacturing Furnaces. *See http://www.dsd.state.md.us/comar/comarhtml/26/26.11.09.08.htm.*

[59] For example, the San Joaquin Valley air district's RACT NOx emission limits are based on both 30-day rolling and daily averages. S*ee* San Joaquin Valley Unified Air Pollution Control District, Rule 4354, "Glass Melting Furnaces" (amended May 19, 2011), available at *https://www.valleyair.org/rules/currntrules/R4354%20051911.pdf.* Wisconsin's NOx emission limits are based on a 30-day rolling average. See Wisconsin's Administrative Code NR Section 428.22 (November 29, 2021), available at *https://casetext.com/regulation/wisconsin-administrative-code/agency-department-of-natural-resources/environmental-protection-air-pollution-control/chapter-nr-428-control-of-nitrogen-compound-emissions/subchapter-iv-nox-reasonably-available-control-technology-requirements/section-nr-42822-emission-limitation-requirements.*

other statewide RACT NOx regulations for this particular sector. A 30-day operating day rolling average strikes a balance between short term (hourly or daily) and long term (annual) averaging periods, while being flexible and responsive to fluctuations in operation and production.

EPA received numerous comments from the glass and glass product industry urging EPA to provide additional flexibilities for glass manufacturing furnaces during periods of startup, shutdown, and idling. In response to these comments, EPA is promulgating alternative work practice standards and emissions limits that may apply in lieu of the emissions limits during periods of startup, shutdown, and idling. EPA has modeled the alternative standards that apply during startup, shutdown, and idling conditions to some extent on State RACT alternative requirements identified by commenters.[60]

EPA has identified the following seven criteria for developing and evaluating alternative emissions limits and other requirements applicable during periods of startup and shutdown:[61]

(1) The revision is limited to specific, narrowly defined source categories using specific control strategies (*e.g.,* cogeneration facilities burning natural gas and using selective catalytic reduction);
(2) Use of the control strategy for this source category is technically infeasible during startup or shutdown periods;
(3) The alternative emission limitation requires that the frequency and duration of operation in startup or shutdown mode are minimized to the greatest extent practicable;
(4) As part of its justification for the SIP revision, the state analyzes the potential worst-case emissions that could occur during startup and shutdown based on the applicable alternative emission limitation;
(5) The alternative emission limitation requires that all possible steps are taken to minimize the impact of emissions during startup and shutdown on ambient air quality;
(6) The alternative emission limitation requires that, at all times, the facility is operated in a manner consistent with good practice for minimizing emissions and the source uses best efforts regarding planning, design, and operating procedures; and
(7) The alternative emission limitation requires that the owner or operator's actions during startup and shutdown periods are documented by properly signed, contemporaneous operating logs or other relevant evidence.

We address each of these criteria below.

(1) The revision is limited to specific, narrowly defined source categories using specific control strategies (*e.g.*, cogeneration facilities burning natural gas and using selective catalytic reduction).

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[60] See, e.g., Pennsylvania Code, Title 25, Part I, Subpart C, Article III, Sections 129.305-129.307 (effective June 19, 2010), available at *http://www.pacodeandbulletin.gov/Display/pacode?file=/secure/pacode/data/025/chapter129/chap129toc.html&d=reduce* and San Joaquin Valley Unified Air Pollution Control District, Rule 4354, "Glass Melting Furnaces," sections 5.5 – 5.7 (amended May 19, 2011), available at *https://www.valleyair.org/rules/currntrules/R4354%20051911.pdf*.

[61] 80 FR 33840, 33912 (June 12, 2015).

The alternative requirements in § 52.44(d)-(f) for startup, shutdown, and idling periods apply to glass melting furnaces using combustion modifications (e.g., low-$NO_X$ burners, flue gas recirculation, or oxy-firing) or post-combustion controls (e.g., SCR or SNCR) to comply with the $NO_X$ emissions limits in this final rule. Periodic startup, shutdown, and idling periods are essential to the proper operation and maintenance of a furnace since these are the only times when furnace operators can conduct maintenance and repairs and install control technologies.

(2) Use of the control strategy for this source category is technically infeasible during startup or shutdown periods.

Generally, combustion modifications, including low-NOx burners and oxy-firing, can be operated even during periods of startup or shutdown, since these types of controls are often integrated into the operation of the furnace unit. However, due to different variations in startup and shutdown procedures in various furnace types, it is generally not possible for furnaces to meet numeric emissions limits expressed as emissions per ton of glass produced during these periods. Since there is no glass being pulled during these periods, it is not possible for furnaces to meet a production-based limit during these periods. Therefore, EPA is finalizing work practice standards that require the operation of controls as soon as technically feasible. Specifically, the alternative requirements in § 52.44(d)-(f) provide that the owner or operator "shall place the emissions control system in operation as soon as technologically feasible during startup to minimize emissions" and similarly "shall operate the emissions control system whenever technologically feasible" during shutdown to minimize emissions, even if these controls do not achieve the same level of performance during startup or shutdown as they do during normal operations.

In addition, EPA expects that some glass furnaces will comply with the final rule through the use of post-combustion controls like SCR, which cannot function properly when the exhaust temperature does not meet the operating conditions needed for the catalyst (i.e., 570 – 840 °F). This may run the risk of forming ammonium bisulfates and result in damage to the equipment. The alternative requirements in § 52.44(d)-(f) provide additional time for flue gas temperatures to reach optimal operating conditions.

During periods when glass pull is not occurring (i.e., idling), fuel must continue to be fired to ensure molten glass does not solidify and damage the furnace. Idling periods occur when there may be a need for a temporary transitional period of the batch material, where shutting down or restarting the furnace may not be feasible. The idling periods allow for the furnace to transition from one different batch of raw materials to the next for operators to transition from one glass product to another. Since the emissions limits under § 52.44(c) are expressed in pounds of NOx per ton of glass produced, it is not possible for a glass furnace to comply with the limits when there is no glass production or abnormally low glass production. However, as with startup and shutdown, owners and operator must operator their controls as soon as technically feasible and must meet a daily emissions limit applicable during idling periods (this is described in more detail under factor 4 below).

(3) The alternative emission limitation requires that the frequency and duration of operation in startup or shutdown mode are minimized to the greatest extent practicable;

The final rule establishes limits on the number of days that each startup or shutdown period may last (ranging from 40 to 104 days), depending on the type of glass furnace. During shutdown operations, the owner or operator is required to measure the duration of the glass melting furnace shutdown. The shutdown period will be measured from the time the furnace operation drops below 25 percent of the permitted production capacity or fuel use capacity to when all emissions from the furnace cease. The shutdown period of the glass melting furnace may not exceed 20 days. Additionally, the owner or operator must maintain operating records and additional documentation as necessary to demonstrate compliance with these requirements.

(4) As part of its justification of the SIP revision, the state analyzes the potential worst-case emissions that could occur during startup and shutdown based on the applicable alternative emission limitation;

In 1994, the Emission Standards Division of the Office of Air Quality Planning and Standards of the U.S. Environmental Protection Agency issued a report detailing alternative control techniques (ACTs) for NOx emissions from glass manufacturing facilities. Within this report, the following table below was included and summarized the uncontrolled NOx emissions identified from glass manufacturing furnaces:[62]

| Furnace type | Uncontrolled $NO_x$ emissions, lb $NO_x$/ton |
|---|---|
| Container glass | 10.0 |
| Flat glass | 15.8[26] |
| Pressed/blown glass | 22.0 |

These values represent worst case NOx emission, in pounds of NOx emitted by ton of glass produced, from each respective glass furnace type during normal operation in the absence of emission control technology.

During periods of idling, affected units must comply with an alternative emission limit calculated in accordance with a specific equation to limit emissions to an amount (in pounds per day) that reflects the furnace's permitted production capacity in tons of glass produced per day. Additionally, the owner or operator must operate the emissions control system to minimize emissions whenever technologically feasible.

(5) The alternative emission limitation requires that all possible steps are taken to minimize the impact of emissions during startup and shutdown on ambient air quality;

[62] EPA, Alternative Control Techniques Document— NOx Emissions from Glass Manufacturing, EPA-453/R-94-037 (June 1994) at 4-10.

The owner or operator must maintain all records necessary to demonstrate compliance with the startup and shutdown requirements. Additionally, the owner or operator must place the emissions control system in operation as soon as technologically feasible during start-up to minimize emissions. During shutdown operations, owner or operators are required to measure the time the furnace operation drops below 25 percent of the permitted production capacity or fuel use capacity to when all emissions from the furnace cease. During this period, the owner or operator of a glass melting furnace must operate the emissions control system whenever technologically feasible during shutdown to minimize emissions.

(6) The alternative emission limitation requires that, at all times, the facility is operated in a manner consistent with good practice for minimizing emissions and the source uses best efforts regarding planning, design, and operating procedures;

During all periods of startup, shutdown, and idling, the owner or operator of a glass melting furnace subject to § 52.44 must operate the emissions control system whenever technologically feasible, in order to minimize emissions during these periods.

(7) The alternative emission limitation requires that the owner or operator’s actions during startup and shutdown periods are documented by properly signed, contemporaneous operating logs or other relevant evidence.

Each owner or operator of an affected unit seeking to comply with alternative work practice standards in lieu of emission limits under § 52.44(c) during startup or shutdown must submit specific information to the Administrator no later than 30 days prior to the anticipated date of startup or shutdown. The following detailed information must be included in this submission: (i) A detailed list of activities to be performed during startup or shutdown and explanations to support the length of time needed to complete each activity; (ii) A description of the material process flow rates, system operating parameters, and other information that the owner or operator shall monitor and record during the startup or shutdown period; (iii) Identification of the control technologies or strategies to be utilized; (iv) A description of the physical conditions present during startup or shutdown periods that prevent the controls from being effective; (v) A reasonably precise estimate as to when physical conditions will have reached a state that allows for the effective control of emissions.

Additionally, each owner or operator must maintain all records necessary to demonstrate compliance with the startup and shutdown requirements, including but not limited to records of material process flow rates, system operating parameters, the duration of each startup and shutdown period, fuel throughput, oxidant flow rate, and any additional records necessary to determine whether the stoichiometric ratio of the primary furnace combustion system exceeded 5 percent excess oxygen during startup. The owner or operator must maintain records of daily $NO_x$ emissions in pounds per day for purposes of determining compliance with the applicable emissions limit for idling periods under paragraph (f)(2). Each owner or operator shall also record the duration of each idling period.

**Performance Tests and Monitoring**

EPA solicited comment on whether it was feasible or appropriate to require affected units to be equipped with CEMS to measure and monitor the NOx concentration (emissions level) instead of conducting performance tests on a semiannual basis.

After review of the comments received at proposal and EPA's assessment of practices conducted within the glass manufacturing industry, EPA is finalizing compliance assurance requirements that allow affected glass manufacturing furnaces to demonstrate compliance with the emissions limits through CEMS or through an annual performance test along with continuous parametric monitoring.

Affected units subject to this rule that operate NOx CEMS meeting specified requirements may use CEMS data in lieu of performance tests and continuous parametric monitoring to demonstrate compliance. For affected units that do not use CEMS, the final rule requires the owner or operator to monitor and record stack exhaust gas flow rate, hourly glass production rate, and stack exhaust temperature during the initial performance test and subsequent annual performance tests to assure compliance with the applicable emissions limit. The owner or operator must then continuously monitor and record those parameters to demonstrate continuous compliance with the NOx emissions limits. To avoid challenges in scheduling and availability of testing firms, the annual performance test does not have to be performed during ozone season. Owners and operators of affected units must also reassess and adjust the site-specific operating parameters in accordance with the results of each performance test, and report and include ongoing site-specific operating parameter data in the annual reports to EPA and the semi-annual title V monitoring reports to the relevant air permitting authority.

# 6 Boilers from Basic Chemical Manufacturing, Petroleum and Coal Products Manufacturing, and Pulp, Paper, and Paperboard Mills, Metal Ore Mining, and the Iron and Steel and Ferroalloys Manufacturing Industry

*A. Applicability and form of final emissions limits for industrial boilers.*

EPA is establishing regulatory requirements for boilers that have a design capacity of 100 mmBtu/hr or greater within the Basic Chemical Manufacturing, Petroleum and Coal Products Manufacturing, Pulp, Paper, and Paperboard Mills, Metal Ore Mining, and the Iron and Steel and Ferroalloys Manufacturing industry. The rationale for the inclusion of these sources in the rule is derived from the Screening Assessment of Potential Emissions Reductions, Air Quality Impacts, and Costs from Non-EGU Emissions Units for 2026, herein referred to as the Non-EGU Screening Assessment, or the Screening Assessment, and further discussed in Section V of the final rule preamble. As described within the Screening Assessment, EPA reviewed the projected 2026 emissions data to identify large boilers within certain industries, defined as boilers projected to emit more than 100 tons per year in 2026. Boilers meeting this threshold were found in five industries, as identified in Table 6.A below.

**Table 6.A: Tier 2 Industries with Large Boilers and Associated NAICS Codes**

| **Industry** | **NAICS Code** |
|---|---|
| Basic Chemical Manufacturing | 3251xx |
| Petroleum and Coal Products Manufacturing | 3241xx |
| Pulp, Paper, and Paperboard Mills | 3221xx |
| Iron and Steel and Ferroalloys Manufacturing | 3311xx |
| Metal Ore Mining | 2122xx |

While certain industries (e.g., Metal Ore Mining) may have relatively few boiler units, each of these five industries was nonetheless found to be impactful of downwind air quality in the Screening Assessment. Further, this rule focuses on boilers as the most impactful emissions-unit types with cost-effective emissions reduction potential within these industries as a whole. Therefore, the final rule applies to boilers in these industries even if an impactful industry may have relatively few boilers. In addition, to the extent such boiler units are used at facilities within any of the other impactful industries covered by the rule (in particular, Iron and Steel and Ferroalloys Manufacturing), because these boilers have a similar profile in terms of cost-effective emissions reduction potential, they too are covered in this final rule.

Based on a review of the potential emissions from industrial boilers of various fuel types as described in this section, use of a boiler design capacity of 100 mmBtu/hr reasonably approximates the selection of 100 tpy used within the Non-EGU Screening Assessment memorandum. Therefore, EPA is establishing NOx emissions limits for all new and existing boilers found within any of the 20 states with non-EGU emission reduction obligations that are within these five industries and have a design capacity of 100 mmBTU/hr or greater. EPA solicited comment on alternative applicability thresholds. Based on comments received on the proposal, we have modified the applicability criteria of the final rule by providing a low-use exemption to boilers that operate less than 10% per year, on an hourly basis, based on the three most recent years of use and no more than 20% in any one of the three years. These units will still have recordkeeping obligations.

EPA reviewed a number of state RACT rules to determine the typical form of emission limits within them. Based on this review, EPA found that NOx limits for industrial boilers most often take a form expressed as mass (i.e., pounds) of NOx emitted per heat input (i.e., million BTUs) combusted per hour. EPA's NOx emissions limits for this source category in this rule take the same form.

Specifically, EPA is establishing an applicability threshold based on a design capacity of 100 mmBtu/hr or greater. NOx emissions from boilers rated at 100 mmBtu/hr or greater can be significant, particularly if they do not operate NOx control equipment. Based on our review of the potential emissions from industrial boilers of various fuel types we conclude that use of a boiler design capacity of 100 mmBtu/hr reasonably approximates the selection of 100 tons/year used within the Non-EGU Screening Assessment memorandum. An evaluation of potential NOx emissions from various fossil-fueled industrial boilers with a design capacity of 100 mmBtu/hr is provided below.

1. Potential emissions from coal-fired industrial boilers

The potential emissions from a coal-fired industrial boiler with a design capacity of 100 mmBtu/hr was estimated using an average NOx emission factor from EPA's emission factor reference document, AP-42,[63] along with an approximate heating value for coal from Appendix A of AP-42. The emission factor used was derived by calculating the average of 13 "A" rated NOx emission factors from AP-42's Table 1.1-3 – Emission Factors for SOx, NOx, and CO from Bituminous and Subbituminous Coal Combustion. The average of the 13 values was 14.1 lbs NOx per ton of coal burned. The heating value from Appendix A for bituminous coal is 13,000 BTUs per pound, which equates to 26 million BTUs per ton of coal. The following calculation provides the maximum potential emissions from an industrial boiler with these parameters:

*(14.1 lbs NOx/ton coal) * (1 ton coal/26 mmBtu) * (100 mmBtu/hr) * (8,760 hr/yr) *(1 ton/2000 lbs) = 237.5 tons NOx/year.*

The above represents the maximum potential emissions from a coal-fired boiler emitting at the rate shown in the equation; boilers operating less than 8,760 hours per year would emit proportionally less than the maximum amount illustrated in the above equation.

2. Potential emissions from oil-fired industrial boilers.

The potential emissions from a residual and a distillate oil-fired industrial boiler with a design capacity of 100 mmBtu/hr was estimated in a manner similar to the approach described

[63] Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources; U.S. EPA, Office of Air Quality Planning and Standards; available at: https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors

above for a coal-fired industrial boiler. For a residual oil-fired industrial boiler, a NOx emission factor of 47 lbs NOx per 1,000 gallons of oil burned was taken from Table 1.3-1, Criteria Pollutant Emission Factors for Fuel Oil Combustion, of section 1.3, Fuel Oil Consumption, of AP-42, and a heating value of 150,000 BTUs per gallon for residual oil as reported in Appendix A to AP-42 was used. The heating value equates to 150 million BTUs per 1,000 gallons used. The following calculation provides the maximum potential emissions from an industrial boiler with these parameters:

> *(47 lbs NOx/1,000 gallons) * (1,000 gallons/150 mmBtu) * (100 mmBtu/hr) * (8,760 hr/yr) *(1 ton/2000 lbs) = 137.2 tons NOx/year.*

For a distillate oil-fired boiler, an emission factor of 24 lbs NOx/1,000 gallons from Table 1.3-1 was used in conjunction with a heat rate of 140,000 BTUs per gallon from Appendix A. Substituting these values into the above equation yields a result of 75.1 tons per year. Although this result is below 100 tons per year, the emission factor used, which was the only one available for industrial boilers of this size and fuel type within AP-42 is rated “D”, meaning there is likely to be a fairly wide range in emission rates from individual boilers of this type.

The above analysis represents the maximum potential emissions from a residual and a distillate-fired industrial boiler emitting at the rates shown in the equations above; boilers operating less than 8,760 hours per year would emit proportionally less than the maximum amounts illustrated in the above equations.

<u>3. Potential emissions from a natural gas-fired industrial boiler.</u>

The potential emissions from a natural gas-fired industrial boiler with a design capacity of 100 mmBtu/hr was estimated in a manner similar to the approach described above for coal and oil-fired industrial boilers. For a natural gas-fired industrial boiler, a NOx emission factor of 235 lbs NOx per million standard cubic feet (SCF) used was obtained from Table 1.4-1, Emission Factors for Nitrogen Oxides (NOx) and Carbon Monoxide (CO) from Natural Gas Combustion, of section 1.4, Natural Gas Consumption, of AP-42. The emission factor represents the average of the emission factors for a pre and a post-NSPS natural gas-fired industrial boiler. A heating value of 1,050 BTUs per SCF as reported in Appendix A to AP-42 was used in the calculation. The heating value equates to 1,050 mmBtu per million SCF. The following calculation provides the maximum potential emissions from an industrial boiler with these parameters:

> *(235 lbs NOx/mm SCF) * (1 mm SCF/1,050 mmBtu) * (100 mmBtu/hr) * (8,760 hr/yr) *(1 ton/2000 lbs) = 98 tons NOx/year.*

The above analysis represents the maximum potential emissions from a residual and a distillate-fired industrial boiler emitting at the rates shown in the equations above; boilers operating less than 8,760 hours per year would emit proportionally less than the maximum amounts illustrated in the above equations. This value is sufficiently close to 100 tpy that applying the 100 mmBtu/hr design capacity for natural-gas fired boilers adequately approximates the 100 tpy figure used in the Screening Assessment.

*B. Final Emissions Limitations and Rationale*

EPA reviewed NOx emissions limits for industrial boilers with design capacities of 100 mmBtu/hr or greater that have been adopted by states and incorporated into their SIPs. Based on that review, EPA is establishing the following $NO_X$ emissions limits for coal, oil, and gas-fired industrial boilers:

**Table 6.B: Final $NO_X$ Emissions Limits for Industrial Boilers > 100 mmBtu/hr**

| **Unit type** | **Emissions limit (lbs NOx/mmBtu)** | **Additional Information** |
|---|---|---|
| Coal | 0.20 | Limits reviewed ranged from 0.08 to 1.0. Final limit will likely require a combination of combustion controls or post-combustion controls. |
| Residual oil | 0.20 | Limits reviewed ranged from 0.15 to 0.50. Final limit will likely require combustion controls. |
| Distillate oil | 0.12 | Limits reviewed ranged from 0.10 to 0.43. Final limit will likely require combustion controls. |
| Natural gas | 0.08 | Limits reviewed ranged from 0.06 to 0.25. Final limit will likely require a combination of combustion controls or post-combustion controls. |

Generally, the emissions limits in Table 6.B can be met through installation and operation of the following controls: 1) SCR for coal-fired boilers; 2) SCR for residual oil-fired boilers; 3) SCR for distillate oil-fired boilers; and low-nox burners and FGR for natural gas-fired boilers.

EPA's Menu of Control Measures (MCM) document contains numerous examples of NOx control equipment that has been demonstrated to effectively reduce emissions from industrial boilers. Table 7 below provides information pertaining to industrial boilers from the MCM, indicating that 9 different control technologies or combinations of technologies have been shown to reduce NOx emissions from industrial boilers with control efficiencies ranging from 35 to 90 percent. This information from the MCM can also be found in the Control Measures Database (CMDB), a major input to the Control Strategy Tool (CoST), which EPA used in the NOx control strategy analysis included in the Non-EGU Screening Assessment memorandum.[64] Table 6.G at the end of this section presents a list of emissions control technologies excerpted from the MCM.

Additional information on EPA's analysis of state-adopted emissions limits for industrial boilers with design capacities of 100 mmBtu/hr or greater fueled by coal, oil, or natural gas, and the control technologies available to reduce NOx emissions from this equipment is provided below.

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[64] EPA, Control Measures Database (CMDB) for Stationary Sources, available at https://www.epa.gov/system/files/other-files/2021-09/cmdb_2021-09-02_0.zip (URL dated January 6, 2022).

1. Coal-fired industrial boilers

For coal-fired industrial boilers subject to the requirements of the final rule, EPA is establishing an emission limit of 0.20 lb/MMBtu on a 30-day rolling basis. Various forms of combustion and post-combustion NOx control technology exist that should enable most existing facilities to be retrofit with equipment that will enable them to meet this emissions limit. Additionally, many states containing ozone nonattainment areas or located within the Ozone Transport Region (OTR) have already adopted emission limits similar to the recommended emission limit. Furthermore, some coal-fired industrial boilers may have installed combustion or post-combustion control equipment to meet the emission limits contained within EPA's NSPS located at 40 CFR 60 Subpart Db, which requires that coal-fired industrial boilers meet a NOx emissions limit of between 0.5 and 0.8 lb/MMBtu depending on unit type.[65]

There are two main types of NOx control technology that can be retrofit to most existing industrial boilers, or incorporated into the design of new boilers, to meet the final emissions limit. These two control types are combustion controls and post-combustion controls, and in some instances both types are used together. As noted within EPA's "Alternative Control Techniques Document – NOx Emissions from Industrial / Commercial / Institutional (ICI) Boilers" (hereafter "ICI Boiler ACT"),[66] the type of NOx control available for use on a particular unit depends primarily on the type of boiler, fuel type, and fuel-firing configuration. We note that although the ICI Boiler ACT also addresses emissions from commercial and institutional boilers, we are not proposing emissions limits for those types of boilers; rather, we are only proposing limits for certain types of industrial boilers. For example, Table 2-3 of the ICI Boiler ACT indicates which types of combustion and post-combustion NOx controls are suitable to various types of coal-fired ICI boilers. We note that one type of combustion control, staged combustion air, and one type of post-combustion control, SNCR, are indicated as being compatible with all coal-fired unit types. Additional resources are available that document the availability of NOx control equipment for industrial boilers, including a document prepared by the Northeast States for Coordinated Air Use Management entitled, "Applicability and Feasibility of NOx, SO2, and PM Emission Control Technologies for Industrial, Commercial, and Institutional Boilers" (November 2008, revised January 2009); the "EPA Air Pollution Control Cost Manual," Section 4, Chapter 1: Selective Noncatalytic Reduction, April, 2019 and Chapter 2, Selective Catalytic Reduction, June 2019; and a document issued by the Institute of Clean Air Companies entitled, "Typical Installation Timelines for NOx Emissions Control Technologies on Industrial Sources," December, 2006.

Table 6.C provides examples of NOx emission limits for coal-fired ICI boilers rated at 100 mmBTU/hr or greater that have been adopted by various states.

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[65] 40 CFR 60.44b.

[66] EPA, Alternative Control Techniques Document – NOx Emissions from Industrial / Commercial / Institutional (ICI) Boilers, EPA-453/R-94-022 [DATE].

**Table 6.C: NOx Emission Limits, Averaging Times, and State Citations for Coal Fired ICI Boilers**

| State | Emission limit (lb/mmBtu) | Averaging time | State rule citation and website |
|---|---|---|---|
| CT | 0.12[67] ozone season;<br><br>0.15 non-ozone season | Daily block average for units with CEMS, for other units, as developed during stack testing. For non-ozone season, rate is avg. for non-ozone season. | Section 22a-174-22e of the Regulations of Connecticut State Agencies, at paragraph (d)(2)(C): https://eregulations.ct.gov/eRegsPortal/Browse/RCSA/Title_22aSubtitle_22a-174Section_22a-174-22e/ |
| MA | 0.12 | One-hour, unless equipped with CEMS, then daily. | Regulation 310 of the Code of Massachusetts Regulations (CMR), 7.00, Air Pollution Control, Section 7.19, RACT for Sources of NOx, at paragraph (4)(b): https://www.mass.gov/doc/310-cmr-700-air-pollution-control-regulations/download |
| DE | 0.38 | 24 hour rolling basis. | Title 7, Natural Resources and Environmental Control, Section 1112, Control of Nitrogen Oxide Emissions, at Table 3-1: https://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml |
| NY | 0.08 – 0.20 | CEMS or 1-hour average. | Title 6, Dept. of Environmental Conservation; Chapter III. Air Resources; Subchapter A. Prevention and Control of Air Contamination and Air Pollution; Part 227. Stationary Combustion Installations; Subpart 227-2. RACT for Major Sources of NOx.<br>NY NOx RACT Regulation |

2. Oil-fired industrial boilers

Most oil-fired boilers are fueled by either residual (heavy) oil or distillate (light) oil. Based on our review of available information as described below, the NOx emission limit for residual oil-fired boilers is 0.20 lb/mmBtu, and the NOx emission limit for distillate oil-fired boilers is 0.12 lb/mmBtu, with both limits based on a rolling, 30-day average basis. As with coal-

[67] Beginning in 2023.

fired industrial boilers, a number of combustion and post-combustion NOx control technologies exist that should enable most facilities to meet these emission limits, and numerous examples exist of states that have already adopted emission limits similar to the emissions limits in this final rule. Table 2-3 of the ICI Boiler ACT indicates that two types of NOx combustion control, low-NOx burners and flue gas recirculation, are commonly found on oil-fueled industrial boilers, and that SNCR, a post-combustion control technology, is suitable to most oil-fueled industrial boilers other than those of the packaged firetube design. Some oil-fired industrial boilers may have already installed combustion or post-combustion control equipment to meet the emission limits contained within EPA's NSPS located at 40 CFR 60 Subpart Db, which requires that distillate oil-fired units meet a NOx emission limit of between 0.1 to 0.2 lb/MMBtu depending on heat release rate, and residual oil-fired units meet a NOx emission limit of between 0.3 to 0.4 lb/MMBtu also depending on heat release rate.[68] The additional resources noted in the paragraph above discussing coal-fired industrial boilers also contain useful information regarding effective NOx control equipment for residual and distillate fueled industrial boilers.

Table 6.D provides examples of NOx emission limits for oil-fired ICI boilers rated at 100 mmBTU/hr or greater that have been adopted by various states.

**Table 6.D: NOx Emission Limits, Averaging Times, and State Citations for Oil-Fired ICI Boilers Rated at 100 mmBTU/hr or Greater**

| **State** | **Emission limit** (lb/mmBTU) | **Averaging time** | **State rule citation** |
|---|---|---|---|
| CT[69] | Residual oil: 0.20<br><br>Other oil: 0.15 | Daily block average for units with CEMS, for other units, as developed during stack testing. | Section 22a-174-22e of the Regulations of Connecticut State Agencies, at paragraph (d)(3)(C): https://eregulations.ct.gov/eRegsPortal/Browse/RCSA/Title_22aSubtitle_22a-174Section_22a-174-22e/ |
| MA | 0.15 | One-hour, unless equipped with CEMS, then daily. | 310 CMR 7.19, at paragraph (4)(b): https://www.mass.gov/doc/310-cmr-700-air-pollution-control-regulations/download |
| DE | 0.25 all boilers except cyclone boilers; cyclone boilers, 0.43 | 24 hour rolling basis. | Title 7, Natural Resources and Environmental Control, Section 1112, Control of Nitrogen Oxide Emissions, at Table 3-1: https://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml |
| NY | 0.15 – 0.20 | CEMS or 1-hour average. | Same citation as shown in Table 3. |

[68] 40 CFR 60.44b.

[69] Rates shown for CT are applicable during the ozone season.

| State | Emission limit (lb/mmBTU) | Averaging time | State rule citation |
|---|---|---|---|
| NJ | Distillate – 0.10<br>Other liq. – 0.20 | If CEMs, daily avg., otherwise, periodic stack test | Title 7, New Jersey Administrative Code, Chapter 27, Subchapter 19, Control and Prohibition of Air Pollution from Oxides of Nitrogen, available at: https://www.nj.gov/dep/aqm/currentrules/Sub19.pdf |
| San Diego County APCD | Distillate - 40 ppm @ 3% O2 (equates to 0.05) | NA | Rule 69.2: Industrial and Commercial Boilers, Process Heaters, and Steam Generators: https://www.sdapcd.org/content/dam/sdapcd/documents/rules/current-rules/Rule-69.2.pdf |

3. Gas-fired industrial boilers

The final NOx emission limit for gas-fired boilers is 0.08 lb/mmBtu on a 30-day rolling average basis. As with fossil-fuel-fired boilers mentioned above, numerous combustion and post-combustion NOx control technology exist that should enable most facilities to meet these emission limits, and many examples exist of states that have already adopted emission limits similar to the emissions limits in this final rule. Table 2-3 of the ICI Boiler ACT indicates the same control technologies suitable to application to oil-fired boilers are also likely to be effective at controlling NOx emissions from gas-fired industrial boilers. Some gas-fired industrial boilers may have already installed combustion or post-combustion control equipment to meet the emission limits contained within EPA's NSPS located at 40 CFR 60 Subpart Db, which requires that gas-fired units meet a NOx emission limit of between 0.1 to 0.2 lb/MMBtu depending on heat release rate. The additional resources noted in the discussion of coal-fired industrial boilers also contain useful information regarding effective NOx control equipment for gas-fired industrial boilers.

Table 6.E provides examples of NOx emission limits for gas-fired ICI boilers rated at 100 mmBTU/hr or greater that have been adopted by various states.

**Table 6.E: NOx Emission Limits, Averaging Times, and State Citations for Gas Fired ICI Boilers with a Design Capacity of 100 mmBTU/hr or Greater**

| State | Emission limit (lb/mmBTU) | Averaging time | State rule citation |
|---|---|---|---|
| CT[70] | 0.10 | Daily block average for units with CEMS, for other units, as developed during stack testing. | Section 22a-174-22e of the Regulations of Connecticut State Agencies, at paragraph (d)(3)(C): https://eregulations.ct.gov/eRegsPortal/Browse/RCSA/Title_22aSubtitle_22a-174Section_22a-174-22e/ |
| MA | 0.06 | One-hour, unless equipped with CEMS, then daily. | 310 CMR 7.19, at paragraph (4)(b): https://www.mass.gov/doc/310-cmr-700-air-pollution-control-regulations/download |
| DE | 0.20 | 24 hour rolling basis. | Title 7, Natural Resources and Environmental Control, Section 1112, Control of Nitrogen Oxide Emissions, at Table 3-1: https://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml |
| NY | 0.08 | CEMS or 1-hour average. | Same as citation shown in Table 3. |
| NJ | 0.10 | If CEMS, daily average; otherwise, periodic stack test. | Title 7, New Jersey Administrative Code, Chapter 27, Subchapter 19, Control and Prohibition of Air Pollution from Oxides of Nitrogen, available at: https://www.nj.gov/dep/aqm/currentrules/Sub19.pdf |
| Bay Area AQMD | 5 ppm @ 3% O2 (equates to 0.006) | NA | Regulation 9, Rule 7:Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-7-nitrogen-oxides-and-carbon-monoxide-from-industrial-institutional-and-commercial-boiler/documents/rg0907.pdf?la=en&rev=ab95f36c2dd146528f1cf3c10596bce3 |

[70] Rates shown for CT are applicable during the ozone season.

| State | Emission limit (lb/mmBTU) | Averaging time | State rule citation |
|---|---|---|---|
| San Diego County APCD | 30 ppm @ 3% O2 (equates to 0.036) | NA | Rule 69.2: Industrial and Commercial Boilers, Process Heaters, and Steam Generators: https://www.sdapcd.org/content/dam/sdapcd/documents/rules/current-rules/Rule-69.2.pdf |

In addition to the above, many BACT determinations exist containing NOx emissions limits for industrial boilers sized 100 mmBTU/hr and greater that are more stringent than the limits shown in the above table. For example, Table B.3 of a document prepared by the Illinois EPA entitled, "Project Summary for a Construction Permit Application from Cronus Chemicals, LLC, for a Fertilizer Manufacturing Facility near Tuscola, Illinois" identifies 17 NOx BACT determinations for boilers sized 100 mmBTU/hr or greater containing emissions limits that range from 0.011 to 0.06 lbs/mmBTU. See: http://www.epa.state.il.us/public-notices/2014/cronus-chemicals/project-summary.pdf. An additional example of stringent NOx emissions limits for gas-fired industrial boilers in this size range can be found within South Carolina's Air Pollution Control Regulations and Standards, within Regulation 61-62. Regulation 62.5, Standard No. 5.2, Control of Oxides of Nitrogen, requires as noted within Table 1 that new industrial boilers sized 100 mmBTU/hr or greater meet a NOx emissions limit of 0.036 lbs/mmBTU.

4. Industrial boilers using other fuels

We anticipated that there may be industrial boilers rated at 100 mmBtu/hr or greater located at one of the indicated industries powered by other fuels such as wood or industrial process gas. EPA solicited comment on whether EPA should establish emission limits for such other types of fuels as part of this action. Based on our review and consideration of comments received on the proposal we decided to finalize emissions limits only for those boilers that receive 90% or more of their heat-input from coal, residual or distillate oil, or natural gas, or combinations of these fuels. We anticipate that most boilers that burn less than 10% of other fuels should be able to meet the emissions limit for the primary fuel burned using identified, cost-effective, conventional control technologies. If not, the final rule provides a mechanism to request from EPA an alternative emissions limit based on a showing of technical impossibility or extreme economic hardship. Based on our understanding of the universe of boilers in the affected states and industries, we anticipate approximately 150 boilers meet the applicability criteria we are adopting in the final rule. Of final note, based on comments received on the proposal the final rule provides a formula that can be used to derive the emissions limit for a boiler that burns combinations of coal, residual oil, distillate oil, or natural gas.

*D. Compliance Assurance Requirements*

Affected units subject to this rule that operate $NO_x$ CEMS meeting specified requirements may use CEMS data in lieu of periodic stack tests and continuous parametric monitoring to demonstrate compliance. Many boilers subject to the requirements of this section of the FIP will likely demonstrate compliance in a manner similar to the emissions monitoring requirements found within the NSPS for industrial, commercial, and institutional (ICI) boilers at 40 CFR Part 60 Subpart D, at section 60.46b. Those requirements include, among other provisions, the performance of an initial compliance test and installation of a CEMS. The final FIP includes a CEMS opt-out provision similar to that within 40 CFR Part 60 Subpart D, Standards of Performance for Fossil-Fuel-Fired Steam Generators, for sources whose initial compliance test indicates the unit emits at 70% or less of the applicable standard. Additionally, based on comments received on the proposal, the final rule allows boilers with heat input capacities of less than 250 mmBTU/hr to perform an alternative monitoring technique that is based on an initial and periodic stack test and development of a parametric monitoring plan.

The final rule requires that the initial compliance test be conducted no later than 90 days after the installation of pollution control equipment applied to meet the emission limits, and performed as described under 40 CFR Part 60.8 using the continuous system for monitoring $NO_X$ specified by EPA Test Method 7E – Determination of Nitrogen Oxide Emissions from Stationary Sources (Instrumental Analyzer Procedure), as described at 40 CFR Part 60, Appendix A-4. The final rule also requires that the initial compliance test be conducted no later than the May 1, 2026 compliance date.

**Table 6.G: Excerpt from Menu of Control Measures Applicable to Industrial Boilers**

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| Industrial/ Commercial/ Institutional Boilers - Coal | Selective Catalytic Reduction | 80 | This control is the selective catalytic reduction of NOx through add-on controls. SCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). The SCR utilizes a catalyst to increase the NOx removal efficiency, which allows the process to occur at lower temperatures. This control applies to coal ICI boilers with NOx emissions greater than 10 tons per year. | EPA 2003b, EPA 1998e |
| Industrial/ Commercial/ Institutional Boilers - Coal | Selective Non-Catalytic Reduction | 40 | This control is the reduction of NOx emission through selective non-catalytic reduction add-on controls. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). This control applies to coal ICI boilers with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2003b, Pechan 2006 |
| Industrial/ Commercial/ Institutional Boilers - Coal or Petroleum Coke | Low NOx Burner | 50 | This control is the use of low NOx burner (LNB) technology to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994g, OTC/LADCO 2010 |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| | | | lowering the temperature of one combustion zone and reducing the amount of oxygen available in another. This control is applicable to coal/wall fired ICI boilers and Petroleum coke fired ICI boilers with uncontrolled NOx emissions greater than 10 tons per year. Cost estimates are from the OTC / LADCO Workgroup (OTC / LADCO Control Cost Subgroup), for a single burner (for a 66% capacity factor at 8760 hours/year), and are based on a methodology similar to EPA's methodology provided in EPA document "Alternative Control Techniques Document – NOx Emissions from Industrial/Commercial/Institutional (ICI) Boilers". | |
| Industrial/ Commercial/ Institutional Boilers - Coal or Petroleum Coke - Wall Fired | Selective Non-Catalytic Reduction | 40 | This control is the reduction of NOx emission through selective non-catalytic reduction add-on controls to wall fired (coal) IC boilers. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). This control applies to coal-fired and petroleum coke-fired IC boilers with uncontrolled NOx | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994g, OTC/LADCO 2010 |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| | | | emissions greater than 10 tons per year. Cost estimates are from the OTC / LADCO Workgroup (OTC / LADCO Control Cost Subgroup), for a single burner (for a 66% capacity factor at 8760 hours/year), and are based on a methodology similar to EPA's methodology provided in EPA document "Alternative Control Techniques Document – NOx Emissions from Industrial/Commercial/Institutional (ICI) Boilers". | |
| Industrial/ Commercial/ Institutional Boilers - Coal/ Bituminous | Low NOx Burner and Over Fire Air | 51 | This control is the use of low NOx burner (LNB) technology and Over Fire Air (OFA) to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering the temperature of one combustion zone and reducing the amount of oxygen available in another. This control applies to bituminous coal Industrial/Commercial/Institutional (ICI) boilers. | EPA 2003b, Pechan 2006 |
| Industrial/ Commercial/ Institutional Boilers - Coal/ Subbituminous | Low NOx Burner | 51 | This control is the use of low NOx burner (LNB) technology to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by | EPA 2003b, Pechan 2006, OTC/LADCO 2010 |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
| --- | --- | --- | --- | --- |
| | | | lowering the temperature of one combustion zone and reducing the amount of oxygen available in another. This control is applicable to subbituminous coal industrial/commercial/institutional boilers. Cost estimates are from the OTC / LADCO Workgroup (OTC / LADCO Control Cost Subgroup), for a single burner (for a 66% capacity factor at 8760 hours/year), and are based on a methodology similar to EPA's methodology provided in EPA document "Alternative Control Techniques Document – NOx Emissions from Industrial/Commercial/Institutional (ICI) Boilers". | |
| Industrial/ Commercial/ Institutional Boilers - Coal/ Cyclone | Coal Reburn | 50 | This control reduces NOx emissions through coal reburn. This control is applicable to coal/cyclone ICI boilers. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 1994g, Cadmus 1995 |
| Industrial/ Commercial/ Institutional Boilers - Coal/ Cyclone | Natural Gas Reburn | 55 | Natural gas reburning (NGR) involves add-on controls to reduce NOx emissions. NGR is a combustion control technology in which part of the main fuel heat input is diverted to locations above the main burners, called the reburn zone. As flue gas | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, ERG 2000, EPA 1994g |

| **Source Category** | **Emission Reduction Measure** | **Control Efficiency (%)** | **Description/Notes/Caveats** | **References** |
|---|---|---|---|---|
| | | | passes through the reburn zone, a portion of the NOx formed in the main combustion zone is reduced by hydrocarbon radicals and converted to molecular nitrogen (N2). This control applies to coal/cyclone ICI boilers with uncontrolled NOx emissions greater than 10 tons per year. | |
| Industrial/ Commercial/ Institutional Boilers - Coal/ Cyclone | Selective Catalytic Reduction | 90 | This control is the selective catalytic reduction of NOx through add-on controls. SCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). The SCR utilizes a catalyst to increase the NOx removal efficiency, which allows the process to occur at lower temperatures. This control applies to coal/cyclone ICI boilers with nameplate capacity greater than 25 MW (250 mmBTU/hr). | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994g, EPA 2010a |
| Industrial/ Commercial/ Institutional Boilers - Coal/ Cyclone | Selective Non-Catalytic Reduction | 35 | This control is the reduction of NOx emission through selective non-catalytic reduction add-on controls. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). This control applies to coal/cyclone IC boilers with | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994g |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| | | | uncontrolled NOx emissions greater than 10 tons per year. | |
| Industrial/ Commercial/ Institutional Boilers - Coal/ Fluidized Bed Combustion | Selective Catalytic Reduction | 90 | This control is the selective catalytic reduction of NOx through add-on controls. SCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). The SCR utilizes a catalyst to increase the NOx removal efficiency, which allows the process to occur at lower temperatures. This control applies to fluidized bed combustion coal ICI boilers. | EPA 2007b |
| Industrial/ Commercial/ Institutional Boilers - Coal/ Fluidized Bed Combustion | Selective Non-Catalytic Reduction - Urea | 75 | This control is the reduction of NOx emission through urea based selective non-catalytic reduction add-on controls. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). This control applies to coal-fired/fluidized bed combustion IC boilers with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994g |
| Industrial/ Commercial/ Institutional | Selective Catalytic Reduction | 90 | This control is the selective catalytic reduction of NOx through add-on controls. SCR controls are post-combustion control technologies based | EPA 2007b |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
| --- | --- | --- | --- | --- |
| Boilers - Coal/ Stoker | | | on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). The SCR utilizes a catalyst to increase the NOx removal efficiency, which allows the process to occur at lower temperatures. This control applies to coal/stoker IC boilers with uncontrolled NOx emissions greater than 10 tons per year. | |
| Industrial/ Commercial/ Institutional Boilers - Coal/ Stoker | Selective Non-Catalytic Reduction | 40 | This control is the reduction of NOx emission through selective non-catalytic reduction add-on controls to coal/stoker IC boilers. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). This control applies to coal/stoker IC boilers with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994g |
| Industrial/ Commercial/ Institutional Boilers - Coal/ Subbituminous | Low NOx Burner and Over Fire Air | 65 | This control is the use of low NOx burner (LNB) technology and Over Fire Air (OFA) to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering the temperature of one combustion zone and reducing the amount of | EPA 2003b, Pechan 2006 |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| | | | oxygen available in another. This control applies to subbituminous coal Industrial/Commercial/Institutional (ICI) boilers. | |
| Industrial/ Commercial/ Institutional Boilers - Coal/ Wall | Selective Catalytic Reduction | 90 | This control is the selective catalytic reduction of NOx through add-on controls. SCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). The SCR utilizes a catalyst to increase the NOx removal efficiency, which allows the process to occur at lower temperatures. This control applies to coal/wall IC boilers with nameplate capacity greater than 25 MW. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994g, EPA 2010a |
| Industrial/ Commercial/ Institutional Boilers - Distillate Oil | Selective Catalytic Reduction | 80 | This control is the selective catalytic reduction of NOx through add-on controls. SCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). The SCR utilizes a catalyst to increase the NOx removal efficiency, which allows the process to occur at lower temperatures. This control applies to distillate oil-fired ICI boilers with nameplate capacity greater than 25 MW. | EPA 2006b, EPA 1998e, EPA 2002a, EPA 2007d, Sorrels 2007, EPA 2010a |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| Industrial/ Commercial/ Institutional Boilers - Distillate Oil or LPG | Low NOx Burner | 50 | This control is the use of low NOx burner (LNB) technology to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering the temperature of one combustion zone and reducing the amount of oxygen available in another. This control is applicable to Oil and LPG ICI boilers with uncontrolled NOx emissions greater than 10 tons per year. Cost estimates are from the OTC / LADCO Workgroup (OTC / LADCO Control Cost Subgroup), for a single burner (for a 66% capacity factor at 8760 hours/year), and are based on a methodology similar to EPA's methodology provided in EPA document "Alternative Control Techniques Document – NOx Emissions from Industrial/Commercial/Institutional (ICI) Boilers". | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994g, OTC/LADCO 2010 |
| Industrial/ Commercial/ Institutional Boilers - Distillate Oil or LPG | Low NOx Burner and Flue Gas Recirculation | 60 | This control is the use of low NOx burner (LNB) technology and FGR to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering the temperature of one combustion zone and reducing the | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1993c |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| | | | amount of oxygen available in another. This control is applicable to distillate oil-fired ICI boilers and LPG-fired ICI Boilers with uncontrolled NOx emissions greater than 10 tons per year. | |
| Industrial/ Commercial/ Institutional Boilers - Distillate Oil or LPG | Selective Non-Catalytic Reduction | 50 | This control is the reduction of NOx emission through selective non-catalytic reduction add-on controls. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). This control applies to distillate oil and LPG-fired IC boilers with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994g |
| Industrial/ Commercial/ Institutional Boilers - Gas | Low NOx Burner and Flue Gas Recirculation + Over Fire Air | 80 | This control is the use of low NOx burner (LNB) technology, flue gas recirculation (FGR), and over fire air (OFA) to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering the temperature of one combustion zone and reducing the amount of oxygen available in another. This control applies to gas | EPA 2003b, EPA 1998e |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| | | | Industrial/Commercial/Institutional (ICI) boilers. | |
| Industrial/ Commercial/ Institutional Boilers - Gas | Low NOx Burner and Over Fire Air | 60 | This control is the use of low NOx burner (LNB) technology and Over Fire Air (OFA) to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering the temperature of one combustion zone and reducing the amount of oxygen available in another. This control applies to gas Industrial/Commercial/Institutional (ICI) boilers. | EPA 2003b, Pechan 2006 |
| Industrial/ Commercial/ Institutional Boilers - Gas | Selective Catalytic Reduction | 80 | This control is the selective catalytic reduction of NOx through add-on controls. SCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). The SCR utilizes a catalyst to increase the NOx removal efficiency, which allows the process to occur at lower temperatures. This control applies to gas-fired ICI boilers with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2003b, EPA 1998e |
| Industrial/ Commercial/ | Selective Non- | 40 | This control is the reduction of NOx emission through selective non- | EPA 2003b, Pechan 2006 |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| Institutional Boilers - Gas | Catalytic Reduction | | catalytic reduction add-on controls. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). This control applies to natural gas fired IC boilers with uncontrolled NOx emissions greater than 10 tons per year. | |
| Industrial/ Commercial/ Institutional Boilers - Natural Gas | Selective Non-Catalytic Reduction | 50 | This control is the reduction of NOx emission through selective non-catalytic reduction add-on controls. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). This control applies to natural gas fired IC boilers with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b |
| Industrial/ Commercial/ Institutional Boilers - Natural Gas or Process Gas | Low NOx Burner | 50 | This control is the use of low NOx burner (LNB) technology to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering the temperature of one combustion zone and reducing the amount of oxygen available in another. This control is applicable to natural gas and process gas fired ICI boilers with | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994g, OTC/LADCO 2010 |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
| --- | --- | --- | --- | --- |
| | | | uncontrolled NOx emissions greater than 10 tons per year. Cost estimates are from the OTC / LADCO Workgroup (OTC / LADCO Control Cost Subgroup), for a single burner (for a 66% capacity factor at 8760 hours/year), and are based on a methodology similar to EPA's methodology provided in EPA document "Alternative Control Techniques Document – NOx Emissions from Industrial/Commercial/Institutional (ICI) Boilers". | |
| Industrial/ Commercial/ Institutional Boilers - Natural Gas or Process Gas | Low NOx Burner and Flue Gas Recirculation | 60 | This control is the use of low NOx burner (LNB) technology and flue gas recirculation (FGR) to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering the temperature of one combustion zone and reducing the amount of oxygen available in another. This control is applicable to natural gas-fired and process gas-fired ICI boilers with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1993c |
| Industrial/ Commercial/ Institutional | Oxygen Trim and | 65 | This control is the use of Oxygen Trim and Water Injection to reduce NOx emissions. Water is injected into the | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, ERG 2000, EPA 1994g |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| Boilers - Natural Gas or Process Gas | Water Injection | | gas turbine, reducing the temperatures in the NOx-forming regions. The water can be injected into the fuel, the combustion air or directly into the combustion chamber. This control applies to natural gas-fired and process gas-fired ICI boilers with uncontrolled NOx emissions greater than 10 tons per year. | |
| Industrial/ Commercial/ Institutional Boilers - Natural Gas or Process Gas | Selective Catalytic Reduction | 80 | This control is the selective catalytic reduction of NOx through add-on controls. SCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). The SCR utilizes a catalyst to increase the NOx removal efficiency, which allows the process to occur at lower temperatures. This control applies to natural gas fired and process gas-fired ICI boilers nameplate capacity greater than 25 MW. | EPA 2006b, EPA 1998e, EPA 2002a, EPA 2007d, Sorrels 2007, EPA 2010a |
| Industrial/ Commercial/ Institutional Boilers - Oil | Low NOx Burner and Over Fire Air | 50 | This control is the use of low NOx burner (LNB) technology and Over Fire Air (OFA) to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering the temperature of one combustion | EPA 2003b, Pechan 2006 |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| | | | zone and reducing the amount of oxygen available in another. This control applies to oil Industrial/Commercial/Institutional (ICI) boilers. | |
| Industrial/ Commercial/ Institutional Boilers - Oil | Selective Catalytic Reduction | 80 | This control is the selective catalytic reduction of NOx through add-on controls. SCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). The SCR utilizes a catalyst to increase the NOx removal efficiency, which allows the process to occur at lower temperatures. This control applies to oil-fired ICI boilers with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2003b, EPA 1998e |
| Industrial/ Commercial/ Institutional Boilers - Oil | Selective Non-Catalytic Reduction | 40 | This control is the reduction of NOx emission through selective non-catalytic reduction add-on controls. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). This control applies to oil IC boilers with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2003b, Pechan 2006 |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| Industrial/ Commercial/ Institutional Boilers - Residual Oil or Liquid Waste | Low NOx Burner | 50 | This control is the use of low NOx burner (LNB) technology to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering the temperature of one combustion zone and reducing the amount of oxygen available in another. This control is applicable to residual oil-fired ICI boilers and liquid waste fired ICI boilers with uncontrolled NOx emissions greater than 10 tons per year. Cost estimates are from the OTC / LADCO Workgroup (OTC / LADCO Control Cost Subgroup), for a single burner (for a 66% capacity factor at 8760 hours/year), and are based on a methodology similar to EPA's methodology provided in EPA document "Alternative Control Techniques Document – NOx Emissions from Industrial/Commercial/Institutional (ICI) Boilers". | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994g, OTC/LADCO 2010 |
| Industrial/ Commercial/ Institutional Boilers - Residual Oil or Liquid Waste | Low NOx Burner and Flue Gas Recirculation | 60 | This control is the use of low NOx burner (LNB) technology and flue gas recirculation (FGR) to reduce NOx emissions. LNBs reduce the amount of NOx created from reaction between fuel nitrogen and oxygen by lowering | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1993c |

| Source Category | Emission Reduction Measure | Control Efficiency (%) | Description/Notes/Caveats | References |
|---|---|---|---|---|
| | | | the temperature of one combustion zone and reducing the amount of oxygen available in another. This control is applicable to residual oil-fired and liquid waste-fired ICI boilers with uncontrolled NOx emissions greater than 10 tons per year. | |
| Industrial/ Commercial/ Institutional Boilers - Residual Oil or Liquid Waste | Selective Non-Catalytic Reduction | 50 | This control is the reduction of NOx emission through selective non-catalytic reduction add-on controls. SNCR controls are post-combustion control technologies based on the chemical reduction of nitrogen oxides (NOx) into molecular nitrogen (N2) and water vapor (H2O). This control applies to residual oil and liquid waste-fired IC boilers with uncontrolled NOx emissions greater than 10 tons per year. | EPA 2006b, Pechan 2001, EPA 1998e, EPA 2002a, EPA 1994g |

The information in the table above is an excerpt from EPA's Menu of Control Measures.

# 7 Municipal Waste Combustors

MWCs include solid waste incinerators and combustors. MWCs emit substantial amounts of NOx, and some states have required emission limits for these facilities that are more stringent than the federal requirements contained within EPA's NSPS for this industry. EPA has received comments in past transport rulemakings that emission reductions should be sought from MWCs, as noted within the RCU proposed rule (85 FR 68993). At proposal, EPA solicited comments on whether $NO_X$ emissions reductions should be sought from municipal waste combustors (MWCs) to address interstate ozone transport and sought comment on whether to require in the final rule specific potential emissions limits, control technologies, and control costs. EPA requested comment on emissions limits of 105 parts per million by volume, dry (ppmvd) on a 30-day average and a 110 ppmvd on a 24-hour average based on determinations made in the June 2021 Ozone Transport Commission (OTC) *Municipal Waste Combustor Workgroup Report* (OTC MWC Report). *See* 87 FR 20085-20086. The OTC MWC Report found that MWCs in the OTR are a significant source of NOx emissions and that significant annual NOx reductions could be achieved from MWCs in the OTR using several different technologies, or a combination of technologies, at a reasonable cost. In consideration of the findings from the OTC MWC report and recent memorandum of understanding (MOU) between OTC states,[71] the fact that many state RACT $NO_X$ rules for ozone nonattainment areas or in the OTR apply to MWCs, and information received during public comment, EPA is finalizing NOx emissions limits of 110 ppmvd at 7 percent oxygen on a 24-hour averaging period and 105 ppmvd at 7 percent oxygen on a 30-day averaging period, applicable to new and existing municipal waste combustor units with a combustion capacity greater than 250 tons per day.

**Summary of MWC Industry and Emissions**

MWCs burn garbage and other non-hazardous solid material using a variety of combustion techniques. Section 2.1, Refuse Combustion, of EPA's emission factor reference document, AP-42, contains a description of the seven different combustion process technologies most commonly used in the industry. These seven combustion processes are as follows: Mass burn waterwall, mass burn rotary waterwall, mass burn refractory wall, refuse-derived fuel-fired, fluidized bed, modular starved air, and modular excess air. Section 2.1 of AP-42 contains detailed process descriptions of each of these MWC processes. During the combustion process, a number of pollutants are produced, including NOx, which forms through oxidation of nitrogen in the waste and from fixation of nitrogen in the air used to burn the waste. NOx emissions from MWCs are typically released through tall stacks which enables the emissions to be transported long distances.

Most MWCs are co-generation facilities in that they recover heat from the combustion process to power a turbine to produce electricity. According to a 2018 report from the Energy Recovery Council,[72] 72 of the 75 operating MWC facilities in the U.S. produce electricity from heat captured from the combustion process. The electrical output of MWCs is relatively small

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[71] Ozone Transport Commission, *Memorandum of Understanding Among the States of the Ozone Transport Commission to Pursue Additional Reductions of Oxides of Nitrogen Emissions from Municipal Waste Combustors* (June 2, 2022).
[72] "2018 Directory of Waste to Energy Facilities"; Energy Recovery Council.

compared to the EGUs that will be regulated per the requirements of the final FIP, with most MWCs having an electrical output capacity of less than 25 MW. Appendix 1 of this TSD contains a Microsoft Excel spreadsheet listing all of the MWC units in the U.S. and includes each unit's electrical output capacity as reflected in EPA's most recent version of the NEEDS database (June 2021). All MWCs in the states included in the final FIP have an electrical output capacity of less than 25 MW. The average electrical output capacity is 12.8 MW.

**MWC Facility Inventory**

EPA conducted an internal analysis of existing MWC facilities across the 20 states subject to this rule. The facility inventory was created using 2019 NEI data as well as 2021 data from the National Electric Energy Data System or "NEEDS" database. These databases provided the facility names and 2019 NOx emissions values. The NOx emissions limit data was sourced from facility operating permits and supplemented by information found in the OTC's MWC report, Appendix A. Information on the type of combustor and the control technology currently installed at these facilities was pulled over from an EPA database and placed in a document entitled "2019 LMWC SMWC Inventory w APCD 09012022," which can be found in the docket's supporting materials. Finally, the "Controls Expected to be Installed" column contains a list of controls that EPA expects facilities to install to achieve the NOx emissions limits, based on the combustor type, the controls already installed, and the cost effectiveness of the control technology compared to other control options. The full MWC facility inventory entitled *MWC Inventory for 2015 Ozone Transport Final Rule* and can be found in the supporting materials of this docket.

NOx emissions from MWCs located in the upwind states identified in this final rule with non-EGU emissions reductions obligations are substantial. According to EPA's NEI database, in 2019 16,924.47 tons of annual NOx were emitted from MWCs in the nine upwind states containing them. Table 7.A contains a list of MWC facilities located within an upwind state covered by this rule along with their NOx emissions as reported to the 2019 NEI.

**Table 7.A: 2019 NOx Emissions from MWC Facilities Located in States Affected by Final FIP**

| State | Facility Name | Combustor Type | Emissions Limit (ppmvd 24-hr limit) | 2019 Emissions |
|---|---|---|---|---|
| CA | Covanta Stanislaus Energy | MB/WW | 165 | 145.07 |
| CA | Covanta Stanislaus Energy | MB/WW | 165 | 145.07 |
| CA | Long Beach City, Serrf Project | MB/WW | 205 | 84.98 |
| CA | Long Beach City, Serrf Project | MB/WW | 205 | 487.45 |
| CA | Long Beach City, Serrf Project | MB/WW | 205 | 96.03 |
| IN | Covanta Indianapolis Inc | MB/WW | 205 | 350.41 |
| IN | Covanta Indianapolis Inc | MB/WW | 205 | 381.16 |
| IN | Covanta Indianapolis Inc | MB/WW | 205 | 390.50 |
| MD | Montgomery County Rrf | MB/WW | 140 | 150.08 |
| MD | Montgomery County Rrf | MB/WW | 140 | 153.28 |
| MD | Montgomery County Rrf | MB/WW | 140 | 166.55 |
| MD | Wheelabrator Baltimore, Lp | MB/WW | 150 | 305.44 |
| MD | Wheelabrator Baltimore, Lp | MB/WW | 150 | 307.53 |
| MD | Wheelabrator Baltimore, Lp | MB/WW | 150 | 310.75 |
| MI | Kent County Waste To Energy Facility | MB/WW | 205 | 153.22 |
| MI | Kent County Waste To Energy Facility | MB/WW | 205 | 153.60 |
| NJ | Covanta Warren Energy Resource Co. L.P. | MB/WW | 150 | 12.19 |
| NJ | Covanta Warren Energy Resource Co. L.P. | MB/WW | 150 | 12.19 |
| NJ | Camden County Energy Recovery Associates L.P. | MB/WW | 150 | 103.76 |
| NJ | Camden County Energy Recovery Associates L.P. | MB/WW | 150 | 103.76 |

| State | Facility Name | Combustor Type | Emissions Limit (ppmvd 24-hr limit) | 2019 Emissions |
|---|---|---|---|---|
| NJ | Camden County Energy Recovery Associates L.P. | MB/WW | 150 | 103.76 |
| NJ | Wheelabrator Gloucester Company L P | MB/WW | 150 | 112.94 |
| NJ | Wheelabrator Gloucester Company L P | MB/WW | 150 | 112.94 |
| NJ | Union County Resource Recovery Facility | MB/WW | 150 | 217.05 |
| NJ | Union County Resource Recovery Facility | MB/WW | 150 | 217.05 |
| NJ | Union County Resource Recovery Facility | MB/WW | 150 | 217.05 |
| NJ | Covanta Essex Company | MB/WW | 150 | 268.30 |
| NJ | Covanta Essex Company | MB/WW | 150 | 268.30 |
| NJ | Covanta Essex Company | MB/WW | 150 | 268.30 |
| NY | Babylon Resource Recovery Facility | MB/WW | 150 | 92.61 |
| NY | Babylon Resource Recovery Facility | MB/WW | 150 | 92.61 |
| NY | Wheelabrator Hudson Falls | MB/WW | 150 | 113.46 |
| NY | Huntington Resource Recovery Facility | MB/WW | 150 | 119.50 |
| NY | Huntington Resource Recovery Facility | MB/WW | 150 | 119.50 |
| NY | Huntington Resource Recovery Facility | MB/WW | 150 | 119.50 |
| NY | Wheelabrator Hudson Falls | MB/WW | 150 | 129.54 |
| NY | Onondaga Co Resource Recovery Facility | MB/WW | 150 | 191.03 |
| NY | Onondaga Co Resource Recovery Facility | MB/WW | 150 | 191.03 |
| NY | Onondaga Co Resource Recovery Facility | MB/WW | 150 | 191.03 |

| State | Facility Name | Combustor Type | Emissions Limit (ppmvd 24-hr limit) | 2019 Emissions |
|---|---|---|---|---|
| NY | Wheelabrator Westchester Lp | MB/WW | 150 | 319.47 |
| NY | Wheelabrator Westchester Lp | MB/WW | 150 | 350.29 |
| NY | Covanta Niagara Lp | MB/WW | 150 | 341.73 |
| NY | Wheelabrator Westchester Lp | MB/WW | 150 | 373.75 |
| NY | Covanta Niagara Lp | MB/WW | 150 | 378.41 |
| NY | Hempstead Resource Recovery Facility | MB/WW | 185 | 346.88 |
| NY | Hempstead Resource Recovery Facility | MB/WW | 185 | 346.88 |
| NY | Hempstead Resource Recovery Facility | MB/WW | 185 | 346.88 |
| OK | Walter B Hall Resource Recovery Facility | CLEERGAS gasification | 205 | 146.26 |
| OK | Walter B Hall Resource Recovery Facility | MB/WW | 205 | 185.95 |
| OK | Walter B Hall Resource Recovery Facility | MB/WW | 205 | 186.26 |
| PA | Lancaster Cnty Swma/Susq Resource Mgmt Complex | MB/WW | 150 | 55.80 |
| PA | Lancaster Cnty Swma/Susq Resource Mgmt Complex | MB/WW | 150 | 66.30 |
| PA | Lancaster Cnty Swma/Susq Resource Mgmt Complex | MB/WW | 150 | 67.60 |
| PA | York Cnty Solid Waste/York Cnty Resource Recovery | MB/RC | 135 | 143.70 |
| PA | York Cnty Solid Waste/York Cnty Resource Recovery | MB/RC | 135 | 152.00 |
| PA | York Cnty Solid Waste/York Cnty Resource Recovery | MB/RC | 135 | 156.30 |
| PA | Covanta Delaware Valley Lp/Delaware Valley Res Rec | MB/RC | 180 | 148.04 |
| PA | Covanta Delaware Valley Lp/Delaware Valley Res Rec | MB/RC | 180 | 163.17 |

| State | Facility Name | Combustor Type | Emissions Limit (ppmvd 24-hr limit) | 2019 Emissions |
|---|---|---|---|---|
| PA | Covanta Delaware Valley Lp/Delaware Valley Res Rec | MB/RC | 180 | 163.27 |
| PA | Lancaster Cnty Rrf/ Lancaster | MB/WW | 180 | 172.55 |
| PA | Lancaster Cnty Rrf/ Lancaster | MB/WW | 180 | 176.11 |
| PA | Covanta Delaware Valley Lp/Delaware Valley Res Rec | MB/RC | 180 | 179.06 |
| PA | Lancaster Cnty Rrf/ Lancaster | MB/WW | 180 | 181.76 |
| PA | Covanta Delaware Valley Lp/Delaware Valley Res Rec | MB/RC | 180 | 185.12 |
| PA | Covanta Delaware Valley Lp/Delaware Valley Res Rec | MB/RC | 180 | 191.95 |
| PA | Wheelabrator Falls Inc/Falls Twp | MB/WW | 150 | 293.45 |
| PA | Wheelabrator Falls Inc/Falls Twp | MB/WW | 150 | 305.81 |
| PA | Covanta Plymouth Renewable Energy/ Plymouth | MB/WW | 180 | 273.92 |
| PA | Covanta Plymouth Renewable Energy/ Plymouth | MB/WW | 180 | 283.20 |
| VA | Wheelabrator Portsmouth | RDF | 250 | 232.14 |
| VA | Wheelabrator Portsmouth | RDF | 250 | 261.26 |
| VA | Wheelabrator Portsmouth | RDF | 250 | 261.34 |
| VA | Wheelabrator Portsmouth | RDF | 250 | 297.56 |
| VA | Covanta Alexandria/Arlington Inc | MB/WW | 110 | 151.79 |
| VA | Covanta Alexandria/Arlington Inc | MB/WW | 110 | 145.20 |
| VA | Covanta Alexandria/Arlington Inc | MB/WW | 110 | 152.39 |
| VA | Covanta Fairfax Inc | MB/WW | 110 | 508.02 |
| VA | Covanta Fairfax Inc | MB/WW | 110 | 514.69 |

| State | Facility Name | Combustor Type | Emissions Limit (ppmvd 24-hr limit) | 2019 Emissions |
|---|---|---|---|---|
| VA | Covanta Fairfax Inc | MB/WW | 110 | 506.39 |
| VA | Covanta Fairfax Inc | MB/WW | 110 | 453.32 |
| | | | **Total** | **16,924.47** |

This inventory and subsequent analysis revealed that all MWC units with a design capacity of 250 tons per day or greater are generally subject to emissions limits ranging from 110 to 250 ppmvd but with an average emissions limit of 163.93 ppmvd. These units include mass burn waterwall combustors, mass burn rotary combustors, refuse derived fuel (RDF) MWCs, and one modular MWC that uses gasification technology called CLEERGAS$^{TM}$ ("Covanta Low Emissions Energy Recovery Gasification"). To be sure that the final applicability threshold capturing units with a design capacity of 250 tons per day or greater, is consistent with the applicability thresholds in terms of PTE applied to other non-EGU sources, we analyzed the PTE of the units captured by the final applicability threshold. We found that in general, a source with a design capacity of 250 tons/day has a PTE of approximately 138 TPY. Additionally, this threshold would capture most incinerators with a PTE greater than or equal to 100 tons per year.

**Summary of Federal NSPS and Emission Guideline NOx limits.**

EPA has promulgated NOx emission limits for large MWCs, defined as those that process 250 tons of municipal solid waste per day or more at 40 CFR Part 60, subpart Cb and 40 CFR Part 60, subpart Eb. Subpart Cb is applicable to MWCs that commenced construction on or before September 20, 1994, while subpart Eb is applicable to MWCs that commenced construction, modification, or reconstruction after September 20, 1994. The NOx limits for subpart Cb are found within Tables 1 and 2 of 40 CFR 60.39b and range from 165 to 250 ppm depending on the combustor design type. The NOx limits for subpart Eb are found at 40 CFR 60.52b(d) and are 180 ppm during a unit's first year of operation and drop to 150 ppm afterwards, applicable across all combustor types.

**NOx limits adopted by states for MWCs.**

Section 182(b)(2) and (f) of the CAA require states containing Moderate or higher classification ozone nonattainment areas to adopt regulations with control requirements representing reasonably available control technology (RACT) for major sources of volatile organic compounds (VOCs) and NOx, and sections 184(b)(1)(B) and 182(f) of the Act require RACT control requirements be adopted in all areas included within the Ozone Transport Region (OTR) established under section 184. Due primarily to the NOx RACT requirement, many states within the Northeast located within the OTR have adopted NOx emission limits for MWCs that are more stringent than what would otherwise be required by EPA's NSPS or emissions guideline for these units. For example, the Montgomery County Resource Recovery Facility in Maryland is required to meet a NOx RACT limit of 140 ppm (@ 7% oxygen) on a 24-hour block average. Additionally, MWC facilities located in Virginia operated by Covanta, Inc., are required to meet a NOx RACT limit of 110 ppm (@ 7% oxygen) on a 24-hour basis, and a limit of 90 ppm (@ 7% oxygen) on an annual average basis.[73]

**Emissions and control options outlined within a June 2021 report from the OTC**

The OTC issued a report entitled "Municipal Waste Combustor Workgroup Report" in June of 2021. The report is included within the docket for this final rule. The report notes that MWCs are a significant source of NOx emissions in the OTR, releasing approximately 22,000 tons of NOx from facilities within nine OTR states in 2018. The report summarizes the results of a literature review of state-of-the-art NOx controls that have been successfully installed on MWCs and concludes that significant reductions could be achieved using several different technologies described in the report, primarily via combustion modifications made to MWC units already equipped with SNCR. The MWC workgroup evaluated the emission reduction potential from two different control levels, one based on a NOx concentration in the flue gas of 105 to 110 ppm, and another based on a limit of 130 ppm. The workgroup's findings were that a control level of 105 ppmvd on a 30-day average basis and a 110 ppmvd on a 24-hour averaging period would reduce NOx emissions from MWCs by approximately 7,300 tons annually, and that a limit of 130 ppmvd on a 30 day-average could achieve a 4,000 tons reduction. The report notes that eight MWC units exist that are already subject to permit limits of 110 ppm, seven in Virginia, and one in Florida. Studies evaluating MWCs similar in design to the large MWCs in the OTR found NOx reductions could be achieved at costs ranging from $2,900 to $6,600 per ton of NOx reduced. Based on the findings of this report, the Commissioners of the states within the OTR adopted a resolution to develop a recommendation for emission reductions from MWCs during their June 15, 2021, annual public meeting.[74]

The OTC's MWC workgroup report describes a literature review to identify additional control technologies to reduce NOx emissions from large MWCs. Based on that review, two control technologies emerged as potentially technically and economically feasible options to achieve the control levels of 105 ppm on a 30-day average basis and a 110 ppm on a 24-hour averaging period: Covanta's "Low-NOx (LN™) technology" and advanced selective non-catalytic reduction (ASNCR).

**Covanta's LN™ Process**

Covanta's LN™ process is a trademarked system which modifies the secondary air (also called overfire air) stream. To complete the combustion process in the MWC furnace, the secondary air is injected through nozzles located in the furnace side walls above the grate to allow turbulent mixing. With the LN™ process, a tertiary air stream is introduced by diverting a portion of secondary air through a new series of air nozzles located higher in the furnace. By controlling the distribution of air between the primary, secondary, and tertiary streams, the optimal gas composition and temperature is achieved to minimize NOx formation. With complete coverage of the furnace cross-section, the tertiary air stream ensures good mixing with

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[73] The NOx permit limits for the Montgomery County facility and the Virginia facilities can be found within the OTC's Municipal Waste Combustor Workgroup Report included within the Docket for this action.
[74] See "Notice of Actions Taken by Ozone Transport Commission At Annual Public Meeting, June 15, 2021" included in the Docket for this action.

the combustion gases. During the $LN^{TM}$ process, only the distribution of air is altered. The total air flow to the MWC is left unchanged.

Approximately 20 units have installed or been retrofitted with the $LN^{TM}$ process, including the two Covanta facilities located in Virginia. However, since the $LN^{TM}$ technology is proprietary, it is available only to Covanta facilities at this time (though there may be potential for licensing agreements with other facilities; however, this is beyond the scope of EPA's analysis).

**Advanced Selective Non-Catalytic Reduction (ASNCR)**

The OTC's MWC report describes a report conducted by Babcock Power for the Wheelabrator Baltimore facility that evaluated several potential NOx control technologies, including ASNCR. ASNCR, like SNCR, involves the injection of reagents (typically ammonia or urea) into the proper temperature zone of the furnace to reduce the NOx concentration within the flue gas. ASNCR also utilizes Computational Fluid Dynamics (CFD) modeling and Chemical Kinetic Modeling (CKM) technology along with real-time furnace temperature maps to modulate which injectors are in operation and the reagent flow rates. This not only significantly decreases NOx emissions but ensures a low ammonia slip (around 5 ppm). ASNCR is currently being installed at Wheelabrator Baltimore and is available to non-Covanta facilities. In addition to the two NOx control technologies described above, the Babcock report also reviewed other NOx control options including optimized SNCR, flue gas recirculation SNCR (FGR-SNCR), and FGR-ASNCR.

**OTC Report's Evaluation of Control Costs**

The OTC's MWC report also evaluated the cost for the installation and operation of the control technologies. The cost effectiveness for $LN^{TM}$ technology were based off of two RACT analyses by Trinity Consultants for the Covanta Alexandria/Arlington and Covanta Fairfax facilities in Virginia. These reports assessed the total capital investment expenditures for the $LN^{TM}$ technology, which includes direct cost (purchasing the equipment) and indirect costs (installation and lost production resulting from extended downtime due to installation). The costs from the installation of the $LN^{TM}$ technology at the Covanta facility in Montgomery County, MD were used to estimate the costs for Covanta Alexandria/Arlington and Covanta Fairfax. Capital costs were annualized, based on projected lifetime of 20 years and a 7% interest rate, and added to the annual operating cost to determine the total yearly costs.[75]

Although the Trinity Consultants reports assumed a controlled NOx value of 90 ppm (the new annual NOx limit at the two Virginia facilities), the OTC's MWC workgroup estimated the cost reduction for a 110 ppm 24-hour limit. This was done because the amount of reagent used and operations and maintenance costs are likely to be higher to achieve a 90 ppm limit, as compared to a 110 ppm 24-hour limit. This resulted in a price decrease of $0.89 per pound of NOx reduced, per information contained in the Babcock report for the Wheelabrator Baltimore facility.

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[75] We note that the analysis referenced in the OTC's MWC report did not specify the dollar year for the total yearly costs, nor for the cost per ton NOx reduced estimates.

The OTC's MWC workgroup then calculated the projected NOx emission reduction based on a 110 ppm limit. To determine the cost effectiveness, the total yearly costs were divided by the NOx emission reduction. Overall, the 110 ppm 24-hour NOx limit cost effectiveness for $LN^{TM}$ technology ranged from $2,900 to $4,639 per ton of NOx reduced.

The OTC's MWC report also evaluated the cost effectiveness of ASNCR to control NOx emissions at MWCs. Cost effectiveness calculations for ASNCR were based off the Babcock report. To evaluate the annualized capital cost, the workgroup utilized a formula from EPA Air Pollution Control Cost Manual and its *Chapter 2 – Cost Estimation: Concepts and Methodology* (US EPA, 2017). Like the Trinity Consultants RACT analyses, a projected lifetime of 20 years and a 7% interest rate were assumed to estimate the annualized capital cost. Also, as with the $LN^{TM}$ technology, the NOx emission reduction for ASNCR was based on a 110 ppm 24-hour limit. For ASNCR, the 110 ppm 24-hour NOx limit cost effectiveness was $6,159 per ton of NOx reduced.

**Evaluation of Cost Controls**

Based on our review of available information as described above, the final NOx emission limit for municipal solid waste combustors is 105 ppm on a 30-day average basis and a 110 ppm on a 24-hour averaging period. A number of NOx control technologies exist that should enable most facilities to meet these emission limits, and numerous examples exist of states that have already adopted emission limits similar to EPA's final emissions limits. The OTC report, outlined above, suggests that Covanta's "Low-NOx ($LN^{TM}$) technology" and advanced selective non-catalytic reduction (ASNCR) are both technically and economically feasible options to achieve the control levels of 105 ppm on a 30-day average basis and a 110 ppm on a 24-hour averaging period.

In order to derive a more case-specific cost effectiveness value for the units subject to this rule, we used the cost effectiveness values estimated in the OTC's MWC report and the data we have on currently installed NOx controls to come up with cost estimates based on the controls we expect facilities to install to meet the final NOx emissions limit (see Table 9).
Given that the LNTM technology is proprietary and therefore, as far as the Agency currently understands, available only to Covanta facilities, we assumed installation of this technology only at Covanta facilities. For all other facilities, we assumed installation or retrofitting of ASNCR. Using the control technology costs outlined in the OTC report, we derived four different annual cost estimates for four different control technology installation scenarios:

1. For units expected to install ASNCR:
    a. The OTC Report cited $1,812,930 in total yearly costs (operating and capital) for installing ASNCR for an MWC with 3 incinerators. Based on this information, we used $604,310 for ASNCR being installed on each incinerator at an MWC.

2. For units expected to install LNTM:
    a. The OTC Report cited total yearly cost (operating and capital) for 1 incinerator ranging from $297,679 to $580,181. Based on this information, we conservatively

assumed $580,181 for any incinerator type that Covanta has indicated can install Low NOx Burners and SNCR.

3. For units that already have ASNCR installed:
    a. The OTC Report cited $995,000 for the annual operating costs of an ASNCR at an MWC with 3 incinerators. Since these facilities already have ASNCR installed, we did not include the capital costs. Based on this information, we used $331,667 for the operating costs of an ASNCR on each incinerator to meet the 110 ppm emission limit.
    b. This estimate is conservative since these units are already operating the installed ASNCR at a lower reagent usage and so are already paying a portion of the $331,667 annual operating costs.

4. For units that already have LNTM and SNCR installed:
    a. Report cited annual operating cost for 1 incinerator ranging from $181,146 to $401,243. Since these facilities already have Low NOx Burners and SNCR installed, we did not include the capital costs. Based on this information we conservatively assumed $401,243 for the additional operating costs to meet the 110 ppm emission limit.
    b. This estimate is also conservative since these units are already operating the installed Low Nox and SNCR at a lower reagent usage and so are already paying a portion of the $401,243 annual operating costs.

We applied these annual costs to the expected emissions reductions resulting from the 110 ppm emissions limit and determined that the estimated weighted average cost per ton across the facilities subject to this rule is $8,323.62.

**Table 7.B: MWC Control Costs**

| State | Site Name | NOx Limit (ppmvd) | % Reduction | NOx Emissions (tons) | Emissions Reductions (tons) | Current Nox Controls | Controls Expected to be Installed |
|---|---|---|---|---|---|---|---|
| CA | Covanta Stanislaus Energy | 165 | 33% | 145.07 | 48.36 | SNCR | ASNCR |
| CA | Covanta Stanislaus Energy | 165 | 33% | 145.07 | 48.36 | SNCR | ASNCR |
| CA | Long Beach City, Serrf Project | 205 | 46% | 84.98 | 39.38 | LNtm +SNCR | None |
| CA | Long Beach City, Serrf Project | 205 | 46% | 87.45 | 40.53 | LNtm +SNCR | None |
| CA | Long Beach City, Serrf Project | 205 | 46% | 96.03 | 44.50 | LNtm +SNCR | None |
| IN | Covanta Indianapolis Inc | 205 | 46% | 350.41 | 162.38 | SNCR | ASNCR |
| IN | Covanta Indianapolis Inc | 205 | 46% | 381.16 | 176.64 | SNCR | ASNCR |
| IN | Covanta Indianapolis Inc | 205 | 46% | 390.50 | 180.96 | SNCR | ASNCR |
| MD | Montgomery County Rrf | 140 | 21% | 150.08 | 32.16 | LNtm +SNCR | None |
| MD | Montgomery County Rrf | 140 | 21% | 153.28 | 32.85 | LNtm +SNCR | None |
| MD | Montgomery County Rrf | 140 | 21% | 166.55 | 35.69 | LNtm +SNCR | None |
| MD | Wheelabrator Baltimore, Lp | 150 | 27% | 305.44 | 81.45 | ASNCR | None |
| MD | Wheelabrator Baltimore, Lp | 150 | 27% | 307.53 | 82.01 | ASNCR | None |
| MD | Wheelabrator Baltimore, Lp | 150 | 27% | 310.75 | 82.87 | ASNCR | None |
| MI | Kent County Waste To Energy Facility | 205 | 46% | 153.22 | 71.01 | SNCR | ASNCR |
| MI | Kent County Waste To Energy Facility | 205 | 46% | 153.60 | 71.18 | SNCR | ASNCR |
| NJ | Covanta Warren Energy Resource Co. L.P. | 150 | 27% | 12.19 | 3.25 | SNCR | LNtm +SNCR |
| NJ | Covanta Warren Energy Resource Co. L.P. | 150 | 27% | 12.19 | 3.25 | SNCR | LNtm +SNCR |
| NJ | Camden County Energy Recovery Associates L.P. | 150 | 27% | 103.76 | 27.67 | SNCR | ASNCR |
| NJ | Camden County Energy Recovery Associates L.P. | 150 | 27% | 103.76 | 27.67 | SNCR | ASNCR |
| NJ | Camden County Energy Recovery Associates L.P. | 150 | 27% | 103.76 | 27.67 | SNCR | ASNCR |
| NJ | Wheelabrator Gloucester Company Lp | 150 | 27% | 112.94 | 30.12 | SNCR | ASNCR |

| State | Site Name | NOx Limit (ppmvd) | % Reduction | NOx Emissions (tons) | Emissions Reductions (tons) | Current Nox Controls | Controls Expected to be Installed |
|---|---|---|---|---|---|---|---|
| NJ | Wheelabrator Gloucester Company Lp | 150 | 27% | 112.94 | 30.12 | SNCR | ASNCR |
| NJ | Union County Resource Recovery Facility | 150 | 27% | 217.05 | 57.88 | SNCR | ASNCR |
| NJ | Union County Resource Recovery Facility | 150 | 27% | 217.05 | 57.88 | SNCR | ASNCR |
| NJ | Union County Resource Recovery Facility | 150 | 27% | 217.05 | 57.88 | SNCR | ASNCR |
| NJ | Covanta Essex Company | 150 | 27% | 268.30 | 71.55 | LN$_{tm}$ +SNCR | None |
| NJ | Covanta Essex Company | 150 | 27% | 268.30 | 71.55 | LN$_{tm}$ +SNCR | None |
| NJ | Covanta Essex Company | 150 | 27% | 268.30 | 71.55 | LN$_{tm}$ +SNCR | None |
| NY | Babylon Resource Recovery Facility | 150 | 27% | 92.61 | 24.70 | SNCR | ASNCR |
| NY | Babylon Resource Recovery Facility | 150 | 27% | 92.61 | 24.70 | SNCR | ASNCR |
| NY | Wheelabrator Hudson Falls | 150 | 27% | 113.46 | 30.26 | none | ASNCR |
| NY | Huntington Resource Recovery Facility | 150 | 27% | 119.50 | 31.87 | SNCR | ASNCR |
| NY | Huntington Resource Recovery Facility | 150 | 27% | 119.50 | 31.87 | SNCR | ASNCR |
| NY | Huntington Resource Recovery Facility | 150 | 27% | 119.50 | 31.87 | SNCR | ASNCR |
| NY | Wheelabrator Hudson Falls | 150 | 27% | 129.54 | 34.54 | none | ASNCR |
| NY | Onondaga Co Resource Recovery Facility | 150 | 27% | 191.03 | 50.94 | SNCR | ASNCR |
| NY | Onondaga Co Resource Recovery Facility | 150 | 27% | 191.03 | 50.94 | SNCR | ASNCR |
| NY | Onondaga Co Resource Recovery Facility | 150 | 27% | 191.03 | 50.94 | SNCR | ASNCR |
| NY | Wheelabrator Westchester Lp | 150 | 27% | 319.47 | 85.19 | SNCR | ASNCR |
| NY | Wheelabrator Westchester Lp | 150 | 27% | 350.29 | 93.41 | SNCR | ASNCR |
| NY | Covanta Niagara Lp | 150 | 27% | 341.73 | 91.13 | SNCR | LN$_{tm}$ +SNCR |
| NY | Wheelabrator Westchester Lp | 150 | 27% | 373.75 | 99.67 | SNCR | ASNCR |

| State | Site Name | NOx Limit (ppmvd) | % Reduction | NOx Emissions (tons) | Emissions Reductions (tons) | Current Nox Controls | Controls Expected to be Installed |
|---|---|---|---|---|---|---|---|
| NY | Covanta Niagara Lp | 150 | 27% | 378.41 | 100.91 | SNCR | LNtm +SNCR |
| NY | Hempstead Resource Recovery Facility | 185 | 41% | 346.88 | 140.63 | SNCR | ASNCR |
| NY | Hempstead Resource Recovery Facility | 185 | 41% | 346.88 | 140.63 | SNCR | ASNCR |
| NY | Hempstead Resource Recovery Facility | 185 | 41% | 346.88 | 140.63 | SNCR | ASNCR |
| OK | Walter B Hall Resource Recovery Facility | 205 | 46% | 146.26 | 67.78 | SNCR | ASNCR |
| OK | Walter B Hall Resource Recovery Facility | 205 | 46% | 185.95 | 86.17 | SNCR | ASNCR |
| OK | Walter B Hall Resource Recovery Facility | 205 | 46% | 186.26 | 86.31 | SNCR | ASNCR |
| PA | Lancaster Cnty Swma/Susq Resource Mgmt Complex | 150 | 27% | 55.80 | 14.88 | SNCR | ASNCR |
| PA | Lancaster Cnty Swma/Susq Resource Mgmt Complex | 150 | 27% | 66.30 | 17.68 | SNCR | ASNCR |
| PA | Lancaster Cnty Swma/Susq Resource Mgmt Complex | 150 | 27% | 67.60 | 18.03 | SNCR | ASNCR |
| PA | York Cnty Solid Waste/York Cnty Resource Recovery | 135 | 19% | 143.70 | 26.61 | SNCR | ASNCR |
| PA | York Cnty Solid Waste/York Cnty Resource Recovery | 135 | 19% | 152.00 | 28.15 | SNCR | ASNCR |
| PA | York Cnty Solid Waste/York Cnty Resource Recovery | 135 | 19% | 156.30 | 28.94 | SNCR | ASNCR |
| PA | Covanta Delaware Valley Lp/Delaware Valley Res Rec | 180 | 39% | 148.04 | 57.57 | SNCR | ASNCR |
| PA | Covanta Delaware Valley Lp/Delaware Valley Res Rec | 180 | 39% | 163.17 | 63.45 | SNCR | ASNCR |
| PA | Covanta Delaware Valley Lp/Delaware Valley Res Rec | 180 | 39% | 163.27 | 63.49 | SNCR | ASNCR |
| PA | Lancaster Cnty Rrf/ Lancaster | 180 | 39% | 172.55 | 67.10 | SNCR | ASNCR |
| PA | Lancaster Cnty Rrf/ Lancaster | 180 | 39% | 176.11 | 68.49 | SNCR | ASNCR |

| State | Site Name | NOx Limit (ppmvd) | % Reduction | NOx Emissions (tons) | Emissions Reductions (tons) | Current Nox Controls | Controls Expected to be Installed |
|---|---|---|---|---|---|---|---|
| PA | Covanta Delaware Valley Lp/Delaware Valley Res Rec | 180 | 39% | 179.06 | 69.63 | SNCR | ASNCR |
| PA | Lancaster Cnty Rrf/ Lancaster | 180 | 39% | 181.76 | 70.68 | SNCR | ASNCR |
| PA | Covanta Delaware Valley Lp/Delaware Valley Res Rec | 180 | 39% | 185.12 | 71.99 | SNCR | ASNCR |
| PA | Covanta Delaware Valley Lp/Delaware Valley Res Rec | 180 | 39% | 191.95 | 74.65 | SNCR | ASNCR |
| PA | Wheelabrator Falls Inc/Falls Twp | 150 | 27% | 293.45 | 78.25 | SNCR | ASNCR |
| PA | Wheelabrator Falls Inc/Falls Twp | 150 | 27% | 305.81 | 81.55 | SNCR | ASNCR |
| PA | Covanta Plymouth Renewable Energy/ Plymouth | 180 | 39% | 273.92 | 106.53 | SNCR | ASNCR |
| PA | Covanta Plymouth Renewable Energy/ Plymouth | 180 | 39% | 283.20 | 110.13 | SNCR | ASNCR |
| VA | Wheelabrator Portsmouth | 250 | 56% | 232.14 | 130.00 | none | ASNCR |
| VA | Wheelabrator Portsmouth | 250 | 56% | 261.26 | 146.31 | none | ASNCR |
| VA | Wheelabrator Portsmouth | 250 | 56% | 261.34 | 146.35 | none | ASNCR |
| VA | Wheelabrator Portsmouth | 250 | 56% | 297.56 | 166.63 | none | ASNCR |
| VA | Covanta Alexandria/Arlington Inc | 110 | 0% | 151.79 | 0.00 | LNtm +SNCR | None |
| VA | Covanta Alexandria/Arlington Inc | 110 | 0% | 145.20 | 0.00 | LNtm +SNCR | None |
| VA | Covanta Alexandria/Arlington Inc | 110 | 0% | 152.39 | 0.00 | LNtm +SNCR | None |
| VA | Covanta Fairfax Inc | 110 | 0% | 508.02 | 0.00 | LNtm +SNCR | None |
| VA | Covanta Fairfax Inc | 110 | 0% | 514.69 | 0.00 | LNtm +SNCR | None |
| VA | Covanta Fairfax Inc | 110 | 0% | 506.39 | 0.00 | LNtm +SNCR | None |
| VA | Covanta Fairfax Inc | 110 | 0% | 453.32 | 0.00 | LNtm +SNCR | None |

**Compliance Assurance Requirements**

MWCs subject to the emissions limits will be required to demonstrate compliance in a manner similar to the NSPS requirements for large MWCs under 40 CFR part 60, subpart Eb. Those requirements include, among other provisions, the performance of an initial performance test and installation of a CEMS.

The final rule provides that, during periods of startup and shutdown, CEMS data is not required to be corrected to 7 percent oxygen and is to be measured at stack oxygen content. This approach is consistent with how EPA has addressed startup and shutdown for other solid-waste incinerators under the Commercial and Industrial Solid Waste Incineration Units rules. *See* 40 CFR part 60, subparts CCCC and DDDD.

We analyze here whether it would be appropriate to apply this provision in this action. EPA has identified the following seven specific criteria as appropriate considerations for developing emission limitations in SIP provisions that apply during startup and shutdown:[76]

(1) The revision is limited to specific, narrowly defined source categories using specific control strategies (*e.g.*, cogeneration facilities burning natural gas and using selective catalytic reduction);
(2) Use of the control strategy for this source category is technically infeasible during startup or shutdown periods;
(3) The alternative emission limitation requires that the frequency and duration of operation in startup or shutdown mode are minimized to the greatest extent practicable;
(4) As part of its justification of the SIP revision, the state analyzes the potential worst-case emissions that could occur during startup and shutdown based on the applicable alternative emission limitation;
(5) The alternative emission limitation requires that all possible steps are taken to minimize the impact of emissions during startup and shutdown on ambient air quality;
(6) The alternative emission limitation requires that, at all times, the facility is operated in a manner consistent with good practice for minimizing emissions and the source uses best efforts regarding planning, design, and operating procedures; and
(7) The alternative emission limitation requires that the owner or operator's actions during startup and shutdown periods are documented.

This rulemaking addresses these seven criteria for emission limitations that apply during startup and shutdown for Large MWCs in the following ways:

(1) The revision is limited to specific, narrowly defined source categories using specific control strategies (*e.g.*, cogeneration facilities burning natural gas and using selective catalytic reduction):

Beginning with the 2026 ozone season and in each ozone season thereafter, emissions limits of 110 ppmvd at 7 percent oxygen on a 24-hour averaging period and 105 ppmvd at 7 percent oxygen on a 30-day averaging period will apply to new or existing municipal waste combustor units with a combustion capacity greater than 250 tons per day (225 megagrams per

[76] 80 Fed. Reg. at 33912.

day) of municipal solid waste that is located within any of the States listed in § 52.40(a)(1)(ii), including Indian country located within the borders of any such State(s).

Of the 80 MWC units that will be subject to this rule, 55 units have SNCR installed, 16 units have SNCR and low $NO_X$ technology installed, three units have ASNCR installed, and 6 have no control technology installed.

(2) Use of the control strategy for this source category is technically infeasible during startup or shutdown periods:

The final rule sets NOx 24-hour block average and 30-day rolling average emission rates corrected to 7% oxygen concentration, to be met at all times except for periods of startup and shutdown.[77] The 24-hour block average and 30-day rolling average emission rates are steady state (normal operation mode) emission limits in parts per million by volume (ppmv), which is a measure of concentration. This concentration measurement is calculated as mass of NOx emitted/volumetric gas flow rate from the stack.

The 24-hour block average and 30-day rolling average emission rates for MWCs are defined as a value of NOx emissions in ppmv, corrected to 7 percent oxygen. Therefore, the 24-hour block average and 30-day rolling average emission rates are mathematically adjusted so that the volumetric gas flow rate from the stack is corrected to 7 percent oxygen. Concentration-based emission limits are not practical during startup and shutdown because it is technically infeasible for MWCs to comply with the emission rates due to the "7 percent oxygen correction factor" that is required to be applied to the NOx 24-hour block average and 30-day rolling average emission rates. During periods of startup and shutdown, the volumetric gas flow rate from the stack is transient, as adjustments are made to the amount of air introduced into the furnace. The mathematical oxygen correction would result in an artificially high NOx "concentration reading," even though the amount (mass) of actual NOx emissions would remain unchanged during startup or shutdown. Therefore, it is necessary to set alternative NOx emission limits based on mass of NOx emitted during periods of startup and shutdown (transient periods). Under the final rule, during startup and shutdown, MWCs must continue meeting 110 ppmvd the 24-hour block average and the 105 ppmvd 30-day rolling average emissions limits without correcting emissions to 7% oxygen.

(3) The alternative emission limitation requires that the frequency and duration of operation in startup or shutdown mode are minimized to the greatest extent practicable:

Under the final rule, the duration of startup and shutdown procedures for large MWC units are not to exceed three hours per occurrence, which minimizes the duration of the startup or shut down to the greatest extent practicable. Additionally, unit owner and operators are economically motivated to minimize the duration of any startups since the shorter the startup the quicker a unit can be brought online to sell steam and/or connect to the grid and sell power.

[77] Beginning with the 2026 ozone season and in each ozone season thereafter.

(4) As part of its justification of the SIP revision, the state analyzes the potential worst-case emissions that could occur during startup and shutdown based on the applicable alternative emission limitation:

As an example of worse case emissions from a unit subject to this rule, see the equations below. These calculations assume that the stack oxygen concentration reaches atmospheric conditions of 20.9 during startup and shutdown. As a representation of worse case emissions, the calculations below use information available on the Wheelabrator Baltimore facility, which demonstrated an oxygen concertation of 10.7% and average flue gas flow of 106,336 dscf/min during the 2017 stack test.[78]

Normal operations mass emissions when meeting the 110 ppmvd at 7% oxygen concentration on a 24-hour block average:

$$110\ ppmvd \text{ x } \frac{20.9 - 10.7}{20.9 - 7} \text{ x } (1.194 \text{ x } 10^{-7}) \text{ x } 106{,}336 \frac{\text{dscf}}{\text{min}} \text{ x } 60 \frac{\text{min}}{\text{hour}} = 61.6 \frac{\text{lb}}{\text{hr}}$$

Startup and shutdown emissions assuming ambient oxygen concentration assuming the unit is emitting 110 ppmvd at 20.9% oxygen:

$$110\ ppmvd \text{ x } \frac{20.9}{20.9} \text{ x } (1.194 \text{ x } 10^{-7}) \text{ x } 106{,}336 \frac{\text{dscf}}{\text{min}} \text{ x } 60 \frac{\text{min}}{\text{hour}} = 83.8 \frac{\text{lb}}{\text{hr}}$$

While EPA expects an increase in emissions during startup and shutdown in situations like this, the 3-hour limitation for startup and shutdowns sufficiently minimize emissions.

(5) The alternative emission limitation requires that all possible steps are taken to minimize the impact of emissions during startup and shutdown on ambient air quality:

The final rule does not provide any exclusions from operating controls. MWCs must follow the same emission reduction practices as during normal operation, including operating their ASNCR or low-NOx burners and SNCR during startup and shutdown. In order to meet the final emissions limits for startup and shutdown, MWCs must meet the same emissions limits as normal operations expect that they are not required to correct CEMS data to 7% oxygen. During startup and shutdown, increased gas flow rates into the furnace result in higher oxygen contents in the stack; however, it will still be necessary for these MWCs to operate their controls in order to achieve the $NO_X$ control technology to achieve the 110 ppmvd on a 24-hour block average and 105 on a 30-day rolling average.

(6) The alternative emission limitation requires that, at all times, the facility is operated in a manner consistent with good practice for minimizing emissions and the source uses best efforts regarding planning, design, and operating procedures:

[78] Maryland Department of Environmental Protection, *Technical Support Document for Amendments to COMAR 26.11.08 – Control of Incinerators*, at 30-31 (September 25, 2019).

In addition to the necessity for controls to be run in order to achieve the emissions limits in the final rule, the final rule includes a requirement for owners and operators to minimize emissions by operating their controls, follow good combustion practices and manufacturer's specifications. Specifically, the final rule requires, at 40 CFR 52.46(d)(5), that:

> The owner and operator of an affected unit shall minimize NOx emissions by operating and optimizing the use of all installed pollution control technology and combustion controls consistent with the technological limitations, manufacturers' specifications, good engineering and maintenance practices, and good air pollution control practices for minimizing emissions (as defined in 40 CFR § 60.11(d)) for such equipment and the unit at all times the unit is in operation.

(7) The alternative emission limitation requires that the owner or operator's actions during startup and shutdown periods are documented:

The final rule requires that sources keep CEMS records demonstrating compliance with the emissions limits and requires records to be kept of the steps taken to minimize emissions as required by 40 CFR 52.46(d)(5).